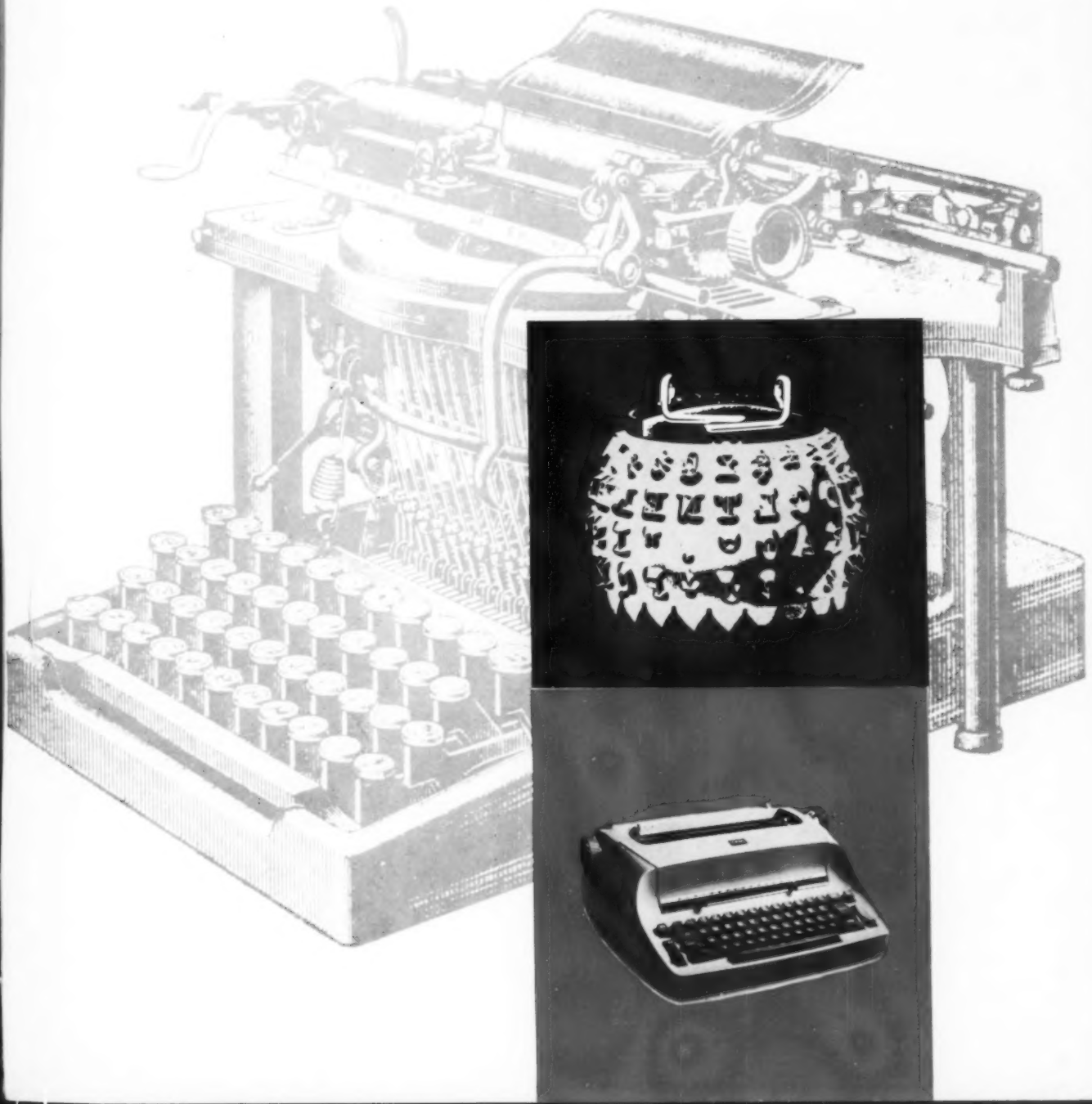
OCTOBER, 1961

PLASTICS

THE MAGAZINE OF APPLIED ENGINEERING

TECHNOLOGY



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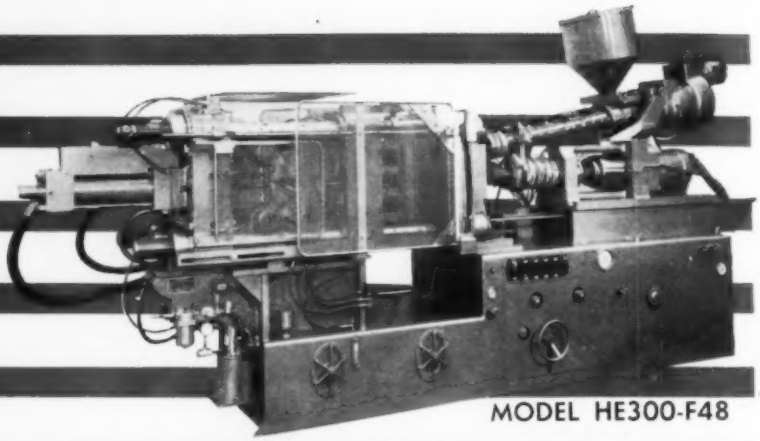

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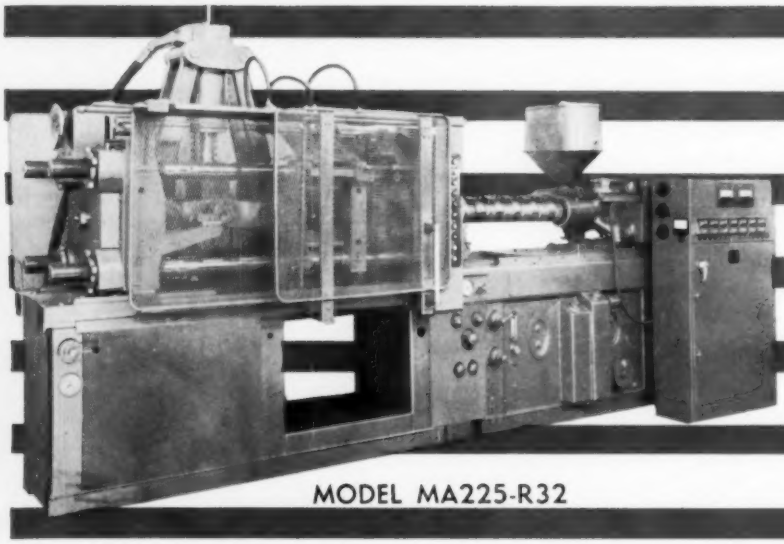

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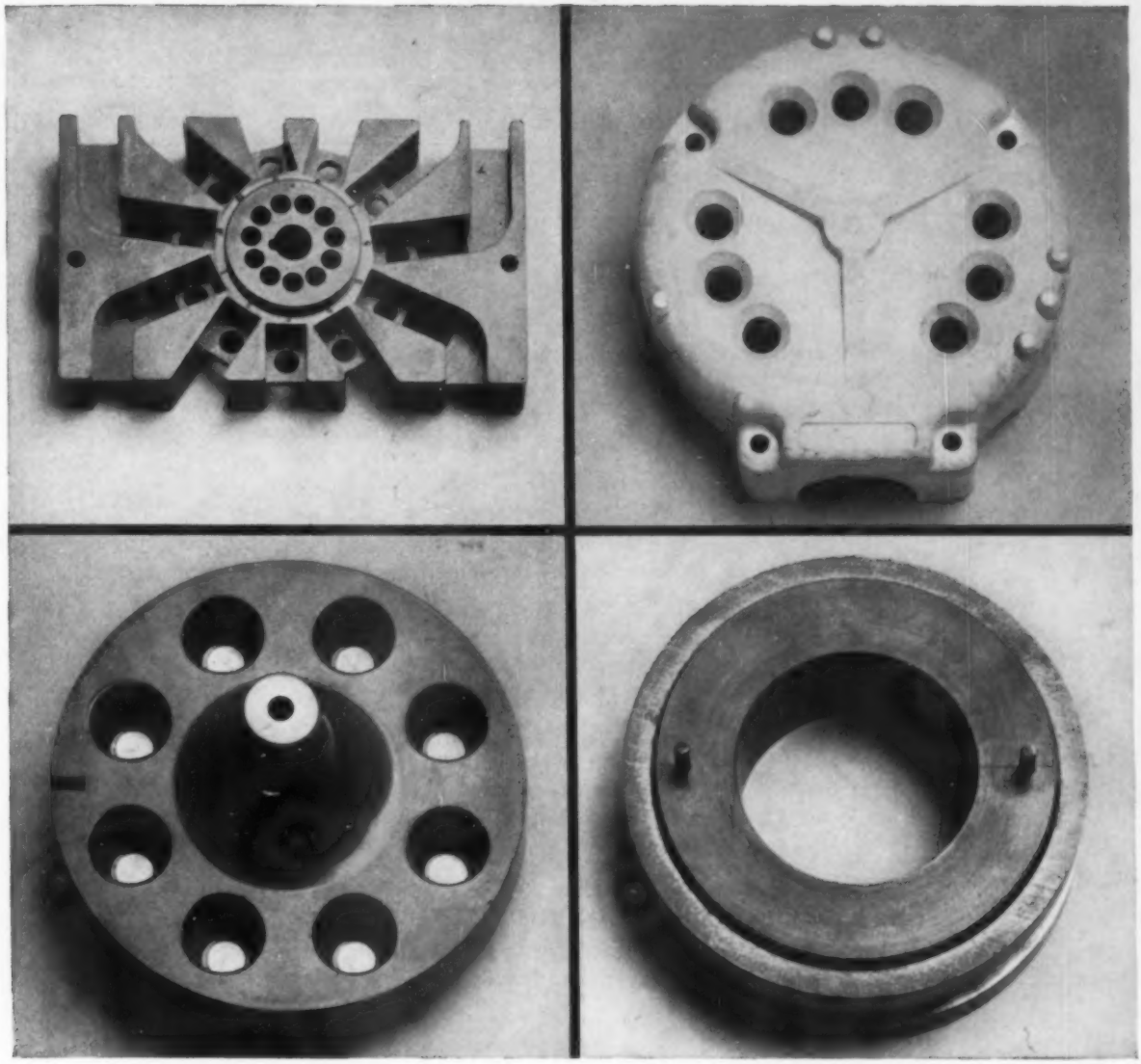

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PLASTICS
THE MAGAZINE OF APPLIED ENGINEERING
TECHNOLOGY

October 1961, Vol. 7, No. 10

feature articles

RIGID URETHANE FOAM—PROCESS VARIABLES AND TEST PROCEDURES p.27

by R. E. Jones

A comprehensive two-part article on the variables involved in making rigid urethane foam for low temperature insulation. Test methods will be covered next month.

PLASTICS PIPE—A PROGRESS REPORT p.35

by E. H. Look

This article shows how an industry can cooperate with its customers and competitors to develop quality standards. The mechanisms involved in coordinating activities are covered.

CUT COSTS WITH DISPOSABLE MANDRELS p.40

by F. Barriner

The making of mandrels for fabrication of reinforced plastic ducting and pressure vessels is described, along with a material which had been developed specifically to overcome previous difficulties.

UREA CONSTITUTES UNIQUE ELEMENT IN NOVEL TYPEWRITER p.42

The new IBM Selectric typewriter uses a urea element bearing different type faces. This unit turns instead of the carriage moving.

exploring fabrication techniques

BIAXIALLY ORIENTED POLYPROPYLENE p.44

by L. J. Zukor

Two methods for producing this film are covered, plus a discussion of difficulties encountered in its extrusion. The film is expected to take over a large portion of the packaging film market.

Cover courtesy of Allied Chemical Corp., Plastics Division, See page 42

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Letters to the editors

Screw injection molding

The May issue of PLASTICS TECHNOLOGY featured an article on "Single Screw Injection Molding" by H. Frimberger and J. Fuller. The article contained many valid comments concerning the comparative operation of plunger type molding machines and those which use extruder plasticization. However, there were also several sections which in our opinion lacked the qualifying information necessary to complete understanding of the subject. In order to aid Mr. Frimberger in comparing European screw machines with American plunger machines, the following comments are offered.

1. The plasticizing curve chart for acrylics in Fig. IC, page 54, shows rates of approximately 40, 45, and 55 pounds per hour for 12, 20, and 32 ounce heating chambers. Realistic figures for American designs in the same sizes are in the ranges of 180, 240, and 360 pounds per hour.

2. The third paragraph on page 57 notes how easily an extruder screw controls shearing forces on the plastic through variation of screw speed and back pressure. It would have been reasonable to include the fact that variation of screw speed and back pressure also affects melt temperature and output rate and that the proper balance of these factors of any given mold setup and screw design is not always readily achieved.

3. The fifth paragraph on page 51 indicates that in preplasticizers —"some material is always forced into the space between the ram and the cylinder wall. Here it gradually decomposes and sloughs back into the melt." If such were the case it would be impossible to mold good parts with heat-sensitive materials such as acetal resin. However, the highly efficient injection pressure on a preplasticizing machine keeps this leakage-lubricant in constant controlled motion away from the melt area. This has been observed in many molding installations.

4. In conjunction with the time-temperature chart on page 5: Mr. Frimberger might have explained further that the curves shown are for one of the few heat sensitive materials, which are seldom used in what we think of as general purpose molding. Comment concerning the relative sizes and designs of the plasticizing units used in compiling the chart data would have given the chart additional importance and meaning.

5. The styrene parts shown photographed in polarized light on page 61 are excellent samples of molding in strains. A more detailed discussion of this area would have pointed out that molded-in strains can result on any type of machine if care is not used in controlling the interrelationship of injection time and pressure, degree of packing, uniform cooling, and melt temperature.

Conrad A. Nelson
Div. Eng., Plastics Machinery
Watson-Stillman Press Div.
Farrel-Birmingham Co., Inc.

We invite letters from our readers for publication in these columns. Such letters may be of comment or criticism, requests for information, or of general interest. The only requirement is that all letters must be fully identified as to name of sender, company affiliation and address.

—The Editor

Articles on schedule

Rigid Urethane Foam—Process Variables and Test Procedures. This second half of an article which began last month covers density distribution in panels, mold preparation and cycle time, and the test procedures themselves. While the article is concerned with Nopcofoam H602, a low-density, fluorocarbon-blown rigid urethane material, the basic technology and procedures are generally applicable to any fluorocarbon-blown rigid urethane.

•

Molds for Blow Molding. This article by T. Kaplan and I. Gordon of Kapgo Plastics emphasizes refinements which can be built into molds —i. e. toggle release mechanisms. Several finishing operations involved in blow molding are covered.

•

Design of Dies for High-Speed Wire Coating by L. R. Hammond of Tennessee Eastman Co. Coating of small gage conductors at high rates of wire travel often gives irregular surfaces which can cause rejection. While much work has been done studying polyethylene flow, little had been accomplished in designing dies for high speed operations. Critical shear rate was increased by using smaller taper angles in the flow channel. Optimum land length was also determined.

•

November is the month for our special section on Extrusion. There will be an article by Goodrich-Gulf, plus all the specifications for American-made and locally available extruders and auxiliary equipment. This section will be an updating of the comparative specifications which appeared in our September, 1960, issue. The specifications compared are those which experts in the extrusion field have determined to be the ones most pertinent and capable of a fair comparison.

NEW FROM
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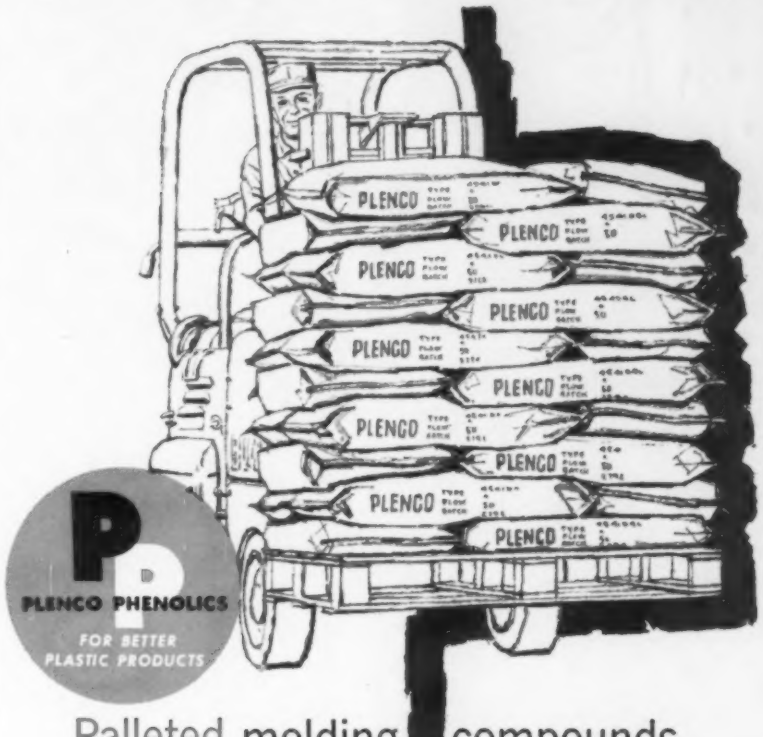

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We don't expect a pat on the back for an idea as simple as this; but it does show that we are thinking in terms of your convenience when using PLENCO products.

a new convenience at no extra cost!

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"This POLYLITE *polyurethane foam* insulation is 5-ways better."

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Leer switched to RCI POLYLITE polyurethane foam insulation after rigidly conducted tests by their own research department proved it gives their ice merchandisers these advantages:

- **Increased cubic capacity**—2-inch thick POLYLITE foam gives better insulation than 3½ inches of another material, permits thinner walls.
- **Weight reduction**—Less POLYLITE foam is used, yet it is more rigid, more adhesive, provides greater structural strength.
- **Floor Space Savings**—Units with substantially larger capacity now fit in the same space.
- **Durability**—POLYLITE foam insulation resists deterioration, is resistant to moisture and most solvents, retains a very low K-factor.
- **Easier installation**—Air-gun mixing and application of POLYLITE chemicals replaces manual operations.

Investigate the advantages of using POLYLITE foam resins in your applications. RCI supplies the complete "package"—including systems for densities from 1¼ to 30 lbs. per cubic foot. Write for details.

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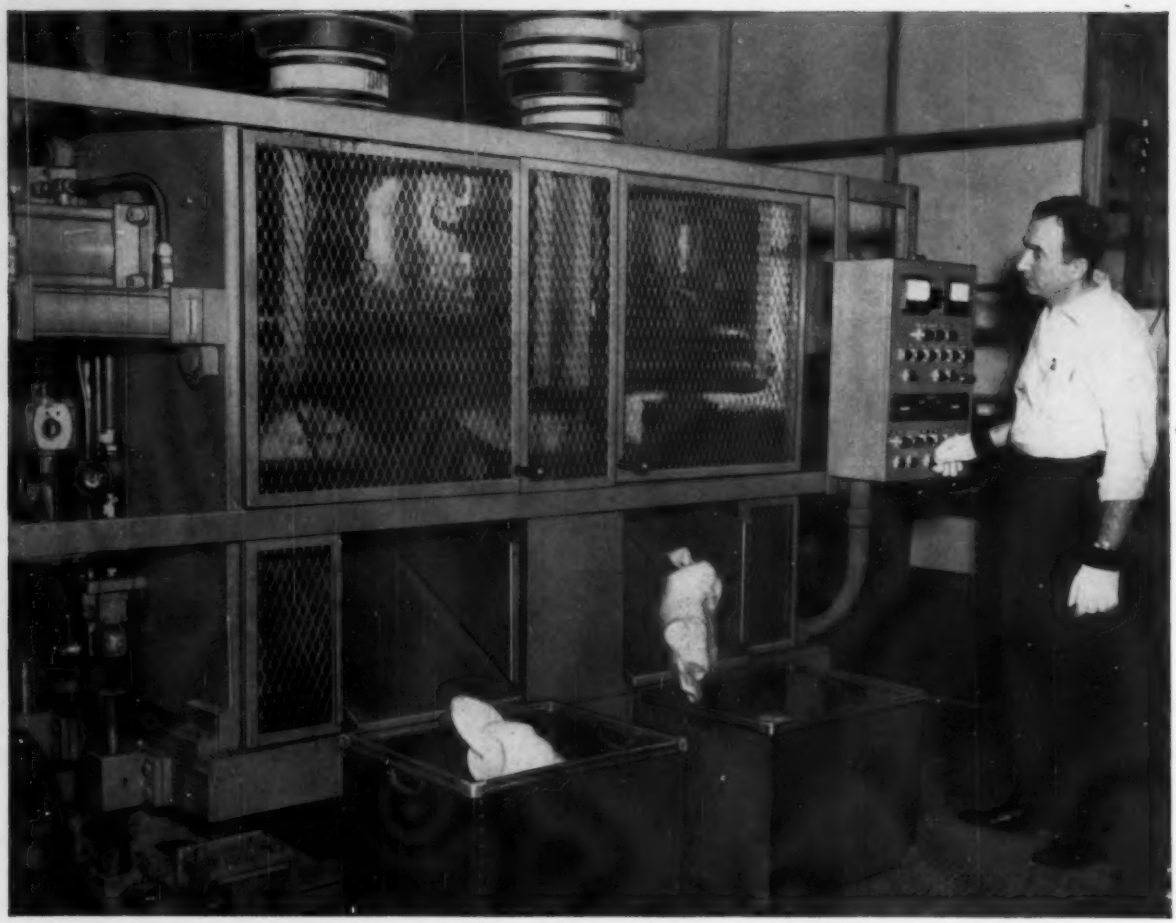
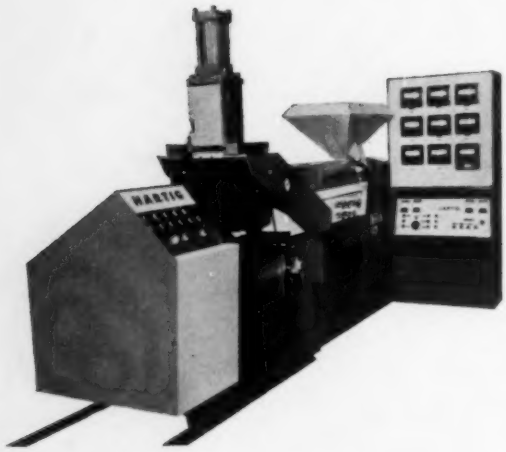


New Hartig blow molding press



in action at Ideal Toy. Shown above is one of the new Hartig blow molding machines producing doll bodies. Operation is continuous and automatic; output is of high quality and uniform; maintenance is simple. This press can handle parts up to 17-inch diameter, is track-mounted for easy mold changes and extruder maintenance.

The Hartig extruder with ram/accumulator provides optimum parison uniformity and shot size.

You are invited to use the experimental blow molding machine in the Hartig laboratory shown at left for experimental production of your parts. Write for specifications.

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U.S.I. POLYETHYLENE NEWS

A series of advertisements for plastics and packaging executives by the makers of PETROTHENE® polyethylene resins

OCTOBER, 1961 — U. S. Industrial Chemicals Co., Division of National Distillers and Chemical Corporation — 99 Park Ave., N. Y. 16, N. Y.

Packaging Notes

Polyethylene pour spout comes in sizes to fit quart and gallon paint cans. Snaps on and off in seconds and is reusable. Keeps paint out of lid groove. Puts an end to messy dripping. Available imprinted with advertising message.

Square-bottom and 3-D style polyethylene bags are being produced by a N. Y. converter from black and natural film in "any size . . . all gauges." A specialty is large, tailored shrouds and covers for domestic and military protective packaging. The largest to date: 450" x 96" x 168". Electronic seals are said to exceed strength of base material.

3-D style polyethylene bag can stand unsupported for easy filling.

Bottom-seal attachment is now available for side weld bag machines made by a leading company. With it, bottom-seal polyethylene bags 8" wide x 16" long can be produced at a rate of 200 per minute. According to the manufacturer, production speeds on large bags are also excellent, since bags up to 65" long may be made with a single stroke.

Tote barrel of molded polyethylene construction has sturdy wire handles and masonite reinforced bottom. It's dent-proof, water-proof and rust-proof, yet light in weight — an ideal multi-purpose container. Available in various sizes, including 25 and 45 gallons.

Polyethylene-Metal Construction Key to Lower-Priced, Higher-Quality Toys

Comparable All-Metal Items Take Longer to Make . . . Retail for More

In the highly competitive toy industry, a slightly lower retail price can be a critical factor—the difference between a good seller and a "shelf-sitter." And therein lies the primary reason why polyethylene is being incorporated in traditionally all-metal toys.

It lowers production costs, and—when used functionally — adds quality. The ultimate result: part-polyethylene, part-metal toys can be marketed at a price lower than all-metal items of similar quality.

Consider the experience of a company which produces nationally-marketed miniature cars, trucks, trailers, vans and boats.

The decision to combine the advantages of polyethylene and metal in a new line was made about a year ago. Since, sales and production figures have verified the success of the venture. According to the firm's purchasing agent:

"Combining polyethylene and metal has enabled us to market a higher quality product within the price range that encompasses our logical market. The polyethylene-metal toys retail for $1.00, which we feel is the right price for this type and size of toy. All-metal toys of this kind would have to retail at $1.19 or $1.29, making it necessary to fight sales resistance that doesn't exist at the $1.00 level."

Secondary Operations Eliminated

On the production line, the polyethylene-metal concept has worked out smoothly and efficiently. Manufacture culminates at the injection molding machines (each of which produces up to 200 polyethylene parts per minute depending on size and complexity), where molding machine attendants join the polyethylene parts with previously-cut metal parts made from zinc castings. Since there's little need to finish, scrape or trim the polyethylene components, secondary operations are virtually eliminated.

Assembly consists simply of securing the plastic part to its metal base by means of slots or undercuts. Wheels of injection-molded black polyethylene are then quickly affixed, and the toy is ready for packaging.

Moving van is typical of part-polyethylene, part-metal toys currently available. Wheels are made from U.S.I.'s PETROTHENE 597 resin, other plastic components from PETROTHENE 241. Chassis and cab are metal. Lower photo shows construction details.

U.S.I.'s Role

U.S.I., as the polyethylene resin supplier, played an important part in the successful development of these toys. U.S.I. engineers were able to assist in establishing optimum equipment operating conditions, such as mold cycle times, and in making suggestions on materials.

The resin selected had to be absolutely uniform and have good strength, stiffness, gloss, colorant dispersion, and shrink and warp resistance. PETROTHENE 241 met these requirements and is being used for all parts but the wheels, which are made from PETROTHENE 597.

His 'n Hers

New from France . . . a nubbly textured polyethylene rain hat designed to be worn by either a man or woman. It comes in a colorful, pocket-sized pouch. Can be turned into a cloche, or into one of a choice of men's styles, in seconds.

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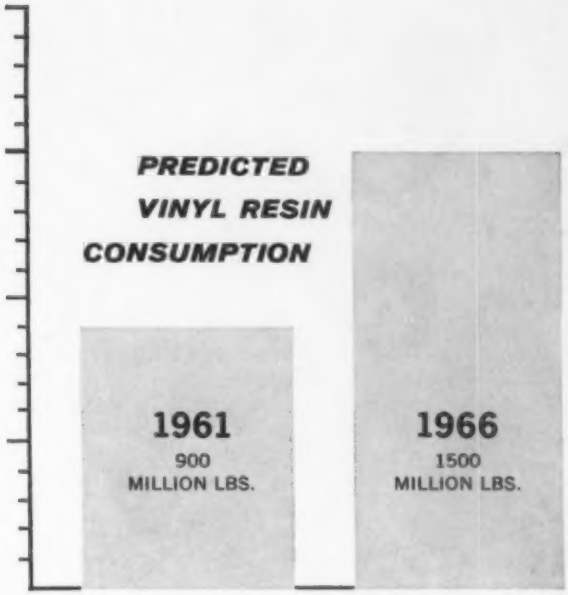

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6. Priceless Technical Assistance

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Organic Chemicals Division
Plasticizer Council, Dept. 4461-A
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Company.....

Street.....

City..... *Zone*..... *State*.....

For more information check Readers' Service Card No. 110

What's New in Processing

A new process for molding expandable polystyrene has been announced by Champlain-Zapata Plastics Machinery Inc., Roseland, N. J. The process is based on pre-expanding equipment that is integrated with the molding process. It is claimed to be the first fully automatic means of molding expandable polystyrene beads.

Specialty Converters, Inc., has announced its method for manufacturing polyurethane foam. Thin sections of foam are cast upon a variety of non-porous substrates. The liquid prepolymer is fed through a mixing head onto a backing as it passes beneath a continuous belt. Calendering rolls are set to control the amount of prepolymer laid on the subtrate. The East Braintree, Mass., company claims the bond of Tufcoate-Foam is stronger than that obtainable by conventional adhesion methods.

Abstracts

"Shaping the Product. 3—Design and Plastics Processing" by Thomas Gray, Plastics, March 1961, is the third in a series on plastics design. This article contributes information on structural strength of moldings, with reference to wall thickness and sharp corners; compression and transfer molding; blow molding, and sheet forming.

"Foam Molding Goes Automatic" by Frank H. Lambert, Modern Plastics, February 1961, outlines the development and features of a process for automatic molding of expandable polystyrene beads.

"Minimizing the Dimensional Instability of Thermoformed Articles" by R. H. Bretton and F. A. Welham, British Plastics, May 1961, shows how careful selection of materials, forming temperatures, and other conditions is important if thermoformed articles are to retain their dimensional stability at relatively high temperatures.

"Vacuum Metallizing" by David K. Sugar, Canadian Plastics, May 1961, describes first and second surface metallizing. It covers design and cost factors, molding precautions, and the nature of the coatings.

"Injection Molding of Polycarbonate" by W. Backofen, Plastverarbeiter, January, February, and March 1961, covers and illustrates right and wrong methods of plunger or screw plasticization molding.

"Construction of Reinforced Polyester Tanks" by G. Papaleo, Poliplasti, March-April 1961, describes the construction of a tank with capacity of 1,057 gallons.

Patents

2,980,962 to Linear, Inc. A process of continuously, automatically molding a milled strip of plastic material into desired article.

2,979,775 to Bearfoot Sole Co., Inc. A method of manufacturing cellular products, from plastic containing a foaming agent, in a closed mold.

2,979,777 to E. I. du Pont de Nemours & Co. Process of stretching tubular thermoplastic film by vapor pressure.

2,973,558 to National Cleveland Corp. A method for deep-draw vacuum forming.

2,979,774 to Montecatini Societa Generale per l'Industria Mineraria e Chimica, Milan, Italy. A process for improving the mechanical properties of articles consisting predominantly of polypropylene.

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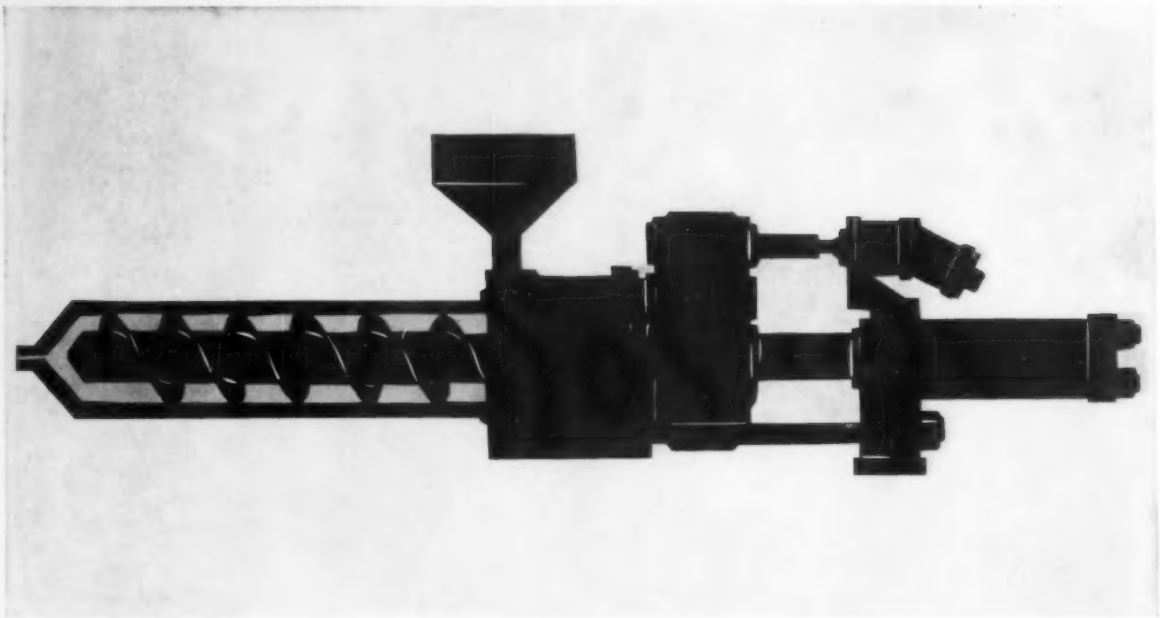
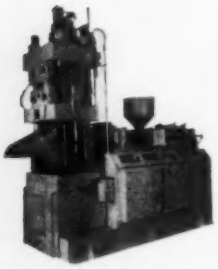


AUTOMATIC INJECTION MOLDING WITH SCREW PLASTICIZING



New Model 706 12-ounce Automatic Injection Molding Press with screw plasticizer.

The new Stokes Model 706 12-ounce Press offers all the proven advantages of truly automatic injection molding with the added features of a newly designed screw plasticizer.

The Stokes-developed plasticizer, combined with proven nozzle shutoff and pressure prepack, speeds production of strain-free parts. The new Model 706 press *plasticizes, molds, de-gates, ejects and sorts automatically.* Even the sprues and runners are channelled into separate bins.

LEADERSHIP FEATURES OF THE NEW STOKES SCREW PLASTICIZER

Unique in-line drive system—All the components of the drive mechanism (screw, piston, etc.) are rigidly mounted in a clean, in-line system. There are no bulky thrust bearings to contend with . . . no thrust overloads to worry about. A single straight shaft links the screw in the plasticizing cylinder with the piston in the ram cylinder.

Completely plasticizes—Uniform plasticizing of the material through mechanical shear permits lower injection pressures for faster, strain-free molding. Ideal for molding all of today's plastics as well as tomorrow's engineering materials.

Color blending—Color blending can be done right in the machine by using dry-blend colors with clear basic material. By adding color in this way, you need only stock the clear plastic. Complete color change on this 12-ounce press has been demonstrated with less than 5 pounds of material.

No drooling, no wasted time—Stokes exclusive positive nozzle shutoff lets you mold nylon and similar materials without drooling, without nozzle change. This shortens injection time by allowing instantaneous withdrawal of the screw, even before gates are fully set up in the mold. Material is ready for injection as soon as press closes.

These are just a few of the many leadership aspects of the Stokes approach to screw plasticizing and automatic injection molding. For more complete details, contact the Stokes representative nearest you. He'll be glad to show you how screw plasticizing combined with the truly automatic features of the Model 706 12-ounce Injection Press can bring new economies to your molding operation. *Plastics Equipment Division, F. J. Stokes Corporation, 5500 Tabor Road, Philadelphia 20, Pa.*

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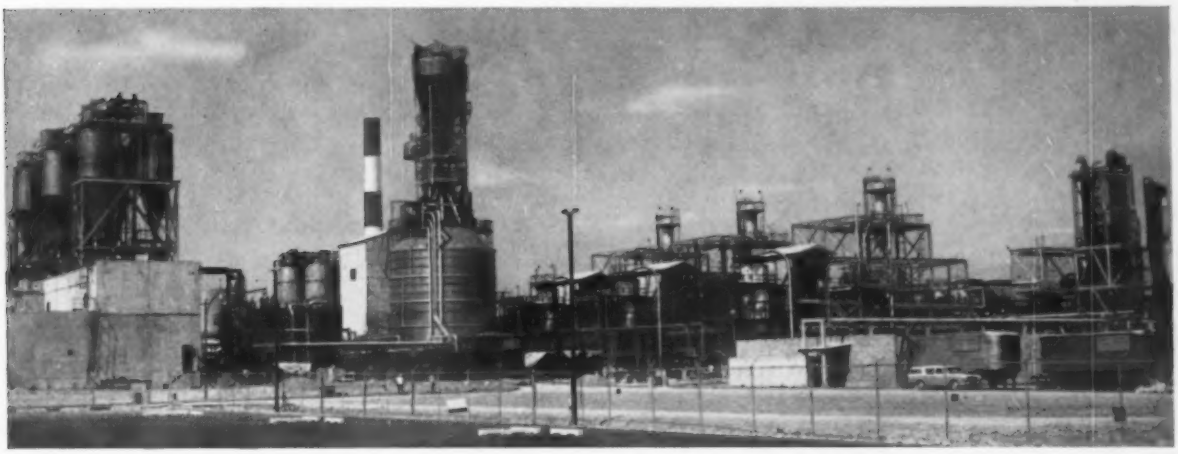
AVISUN

announces world's biggest polypropylene plant now in production



100 million lb/yr capacity assures ample supplies of polypropylene for the fast-growing number of users

This giant new plant at New Castle, Del., establishes AviSun more firmly than ever as the industry's leading polypropylene supplier. It incorporates the most advanced manufacturing techniques—continuous processing—meticulous quality control—to produce polypropylene polymers of top quality and dependable uniformity. The polymers include a broad new range of impact grades, pipe grades and other specialty resins for fiber —and wrapping film in varying mil thicknesses.

From this great new facility will come the materials for strong, light, low-cost products of every description to meet the needs of home and industry.

And AviSun stands ready with technical assistance. Fully equipped Customer Service laboratories—specialists with a broad and diversified background of experience in application problems—are at your service.

So plan now to explore the advantages of manufacturing or packaging with AviSun polypropylene. Complete technical data on AviSun polymer and film will be sent on request.

AVISUN CORPORATION
Executive Offices
1345 Chestnut St., Philadelphia 7, Pa.
In Canada-Courtaulds Plastics Canada, Ltd.

AVISUN*

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Another First from AVISUN...

OLEFORM*

a new, unusually low-cost thermoplastic now available for experimental testing...

Featuring—Unusual toughness and rigidity ● High heat resistance ● Excellent chemical resistance ● Low moisture absorption ● Good electrical insulation qualities

In rigidity and toughness Oleform compares favorably with thermosetting materials in many applications. And its improved creep resistance and mold shrinkage factors excel those of polyolefins. It can be injection molded satisfactorily, thus permitting faster mold cycles than for compression molded thermosetting materials. Its electrical insulation properties compare well with those of thermosets. And unlike thermosets, its molding scrap is reuseable.

Oleform is available in a blue-gray molding grade in *experimental* quantities. AviSun technical specialists stand ready to assist you in any developmental work. For full details, fill in and mail coupon today.

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In Canada: *Courtaulds Plastics Canada, Ltd.*

COMPARISON

Properties	ASTM	OLEFORM	Acetal	Nylon 66	Wood Flour Filled Phenolic
Mechanical[a]					
Tensile Yield Strength[b], 10^3 psi	D638	4.5	9.8	8.5-9	7.5
Elongation at Yield[b], %	D638	6	10	60	1
Tensile Modulus[c], 10^5 psi	D638	2.9	3.75	1.75	10
Flexural Modulus[d], 10^5 psi	D790	5.5	4.1	1.75	10
Izod Impact Strength, ft-lb/in notch	D256	0.9	1.4	2.0	0.3
Physical					
Specific Gravity	D792	1.24	1.43	1.14	1.45
Heat Distortion Temp., °F	D648				
at 66 psi		295	338	360-390	300
at 264 psi		205	212	150-170	275
Water absorption (24 hr.) %	D570	0.02	0.12	1.5	0.6
Lin. Coef. of Ther. Exp., 10-5 in/in/°C	D696	3.8	8.1	10	3.8
Chemical Resistance					
Acids		Excellent	Attacked	Attacked	Good
Bases		Excellent	Attacked	Excellent	Attacked
Solvents		Good	Excellent	Good	Good
COST					
Cents/lb		36	65	98	22
Cents/cu in		1.5	3.3	4.0	1.2

[a] Injection molded specimens at room temperature
[b] Crosshead speed 1/min
[c] Crosshead speed 0.2/min
[d] Crosshead speed 0.05/min

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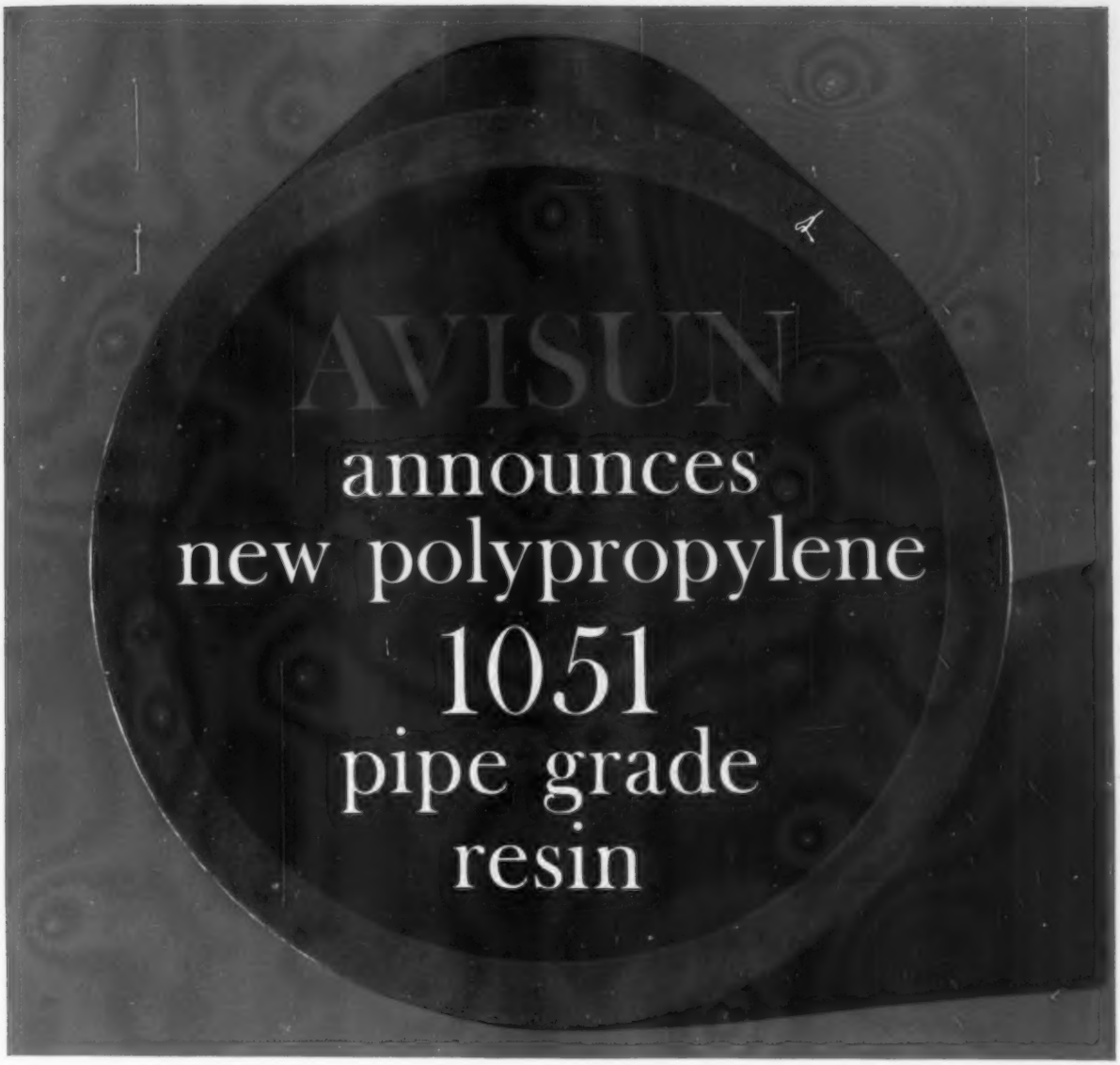

● Easy fabrication ● Easy welding and joining ● Light weight ● Low cost ● High heat resistance ● High chemical resistance ● Low friction loss ● Approved for potable water use by National Sanitation Foundation

In an important advance stemming from extensive research, AviSun introduces the first high molecular weight polypropylene pipe grade resin combining low cost with excellent properties. It has been broadly tested with highly satisfactory results. AviSun pipe grade resin can be processed in most conventional plastic extruders—at rates equal to or greater than that of linear polyethylene. Its high per-pound yield makes it one of the most economical plastics.

Because of the attractive properties, pipe from this resin should yield optimum performance in such applications as: salt water disposal lines; gas gathering and distribution systems; crude oil flow lines; conduit; municipal water systems; process lines for organic and inorganic chemicals; automotive and aircraft tubing, and many others. For more data on AviSun polypropylene 1051 pipe grade resin, fill in coupon.

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Send me complete data on new 1051 pipe grade resin.

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Company_____

Address_____

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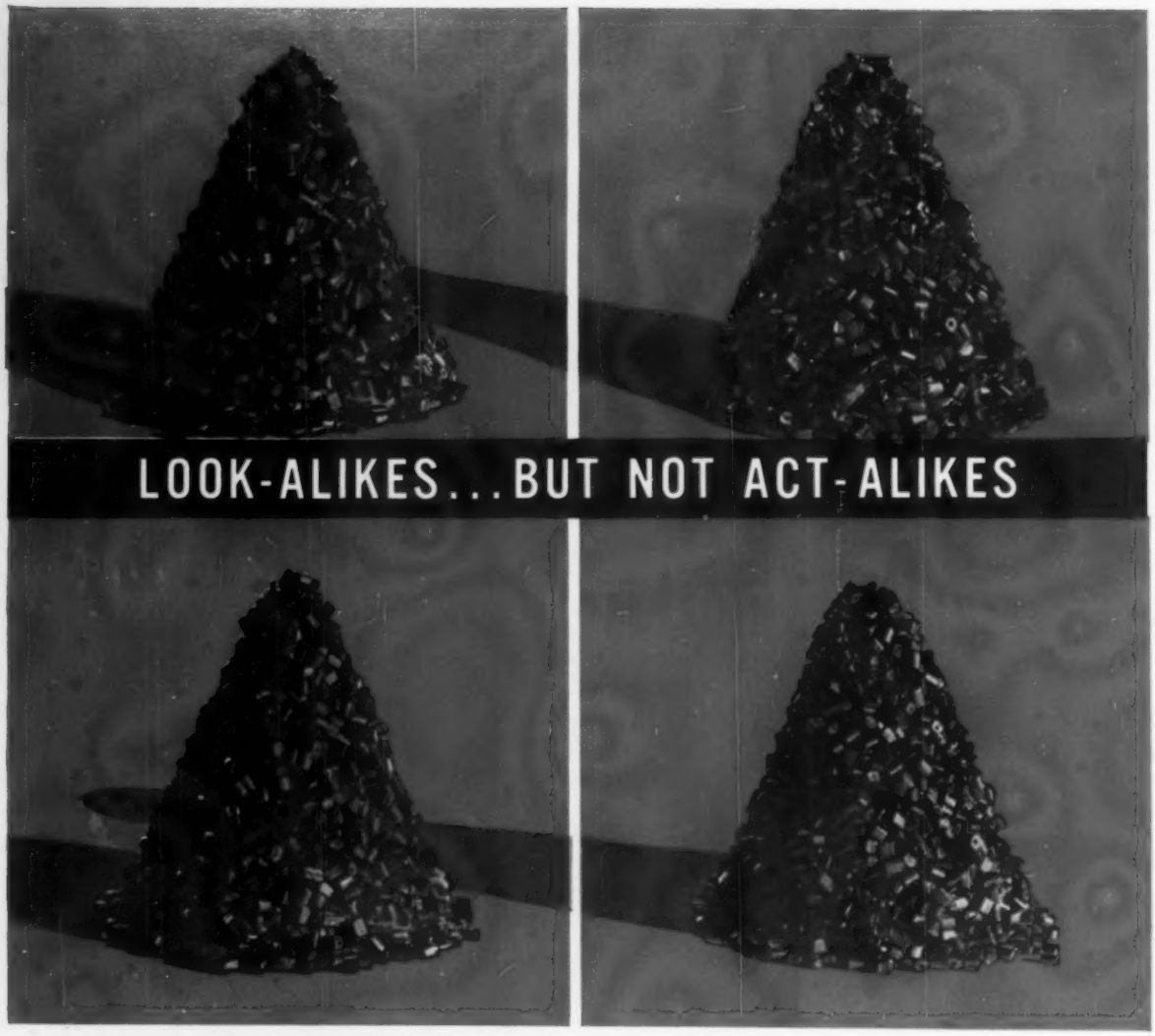

AVISUN announces four new impact grades of polypropylene

Here, for the first time, are new impact grades of polypropylene—all possessing a translucent white resin color—with flow rates suitable not only for injection molding, but also for sheet extrusion, vacuum forming and blow molding. All four retain desirable properties characteristic of general purpose polypropylene—lightness, low cost, high heat and chemical resistance. *But each grade offers a step-up in impact strength at room temperatures.* Equally important, most of this strength is retained at lower temperatures—in the case of High Impact Grade 3210, as low as 10°F.

AviSun technical specialists can help if you plan to use a new AviSun impact grade of polypropylene for *your* product. For full technical data or counsel, write to us.

SPECIAL PROPERTIES

Property	Impact Grade 3116	Impact Grade 3216	High Impact Grade 3211	High Impact Grade 3210
Izod Impact Notched—ft-lb/in Unnotched	1.5 over 16	2.0 over 16	10 over 16	15 over 16
Flow rate—gm/10 min (nominal)	5.0	5.0	0.7	0.5
Type of molding	injection	injection	sheet extrusion vacuum forming	blow

AVISUN CORPORATION
Dept. 620
1345 Chestnut St.
Philadelphia 7, Pa.
In Canada: *Courtaulds Plastics Canada, Ltd.*

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For more information check Readers' Service Card No. 116

Five-gallon standard solution bottle and gallon jug with handle are examples of laboratory ware blow-molded by The Nalge Co., Inc., Rochester, N.Y.

they're better ...cost less

blow-molded of AVISUN polypropylene

From laboratory ware to picnic jug liners, AviSun polypropylene is finding many applications in fields long limited to glass.

1 HIGH HEAT RESISTANCE. Polypropylene blow-molded containers can be repeatedly sterilized with boiling water or autoclaved with live steam.

2 TOUGHNESS. Strongest and lightest of all thermoplastics, polypropylene bottles survive drops and hard knocks without cracking or shattering. Lightweight polypropylene vessels are easier to handle, unlikely to slip when wet. Threads for caps aren't damaged by overtightening.

3 CHEMICAL RESISTANCE. Polypropylene is ideal for holding liquids. It is inert, doesn't absorb liquids, resists stains and is unaffected by most reagents. F.D.A. approved.

4 ECONOMY. Lightweight, low-cost polypropylene is readily blow-molded, gives more bottles per pound of resin, lower packaging and shipping costs, for true economy in the final product.

The same advantages that make polypropylene valuable for these large containers can work for you in your product. Call on AviSun for complete polypropylene specifications and expert technical assistance.

AVISUN*

*a trademark of AviSun Corp.

In Canada: Courtaulds Plastics Canada, Ltd.

AVISUN CORPORATION
Dept. 587, 1345 Chestnut St.
Philadelphia 7, Pa.

Please send full information on blow-molding grades of AviSun polypropylene.

NAME_____
(Please Print)

COMPANY_____

ADDRESS_____

CITY_____ STATE____

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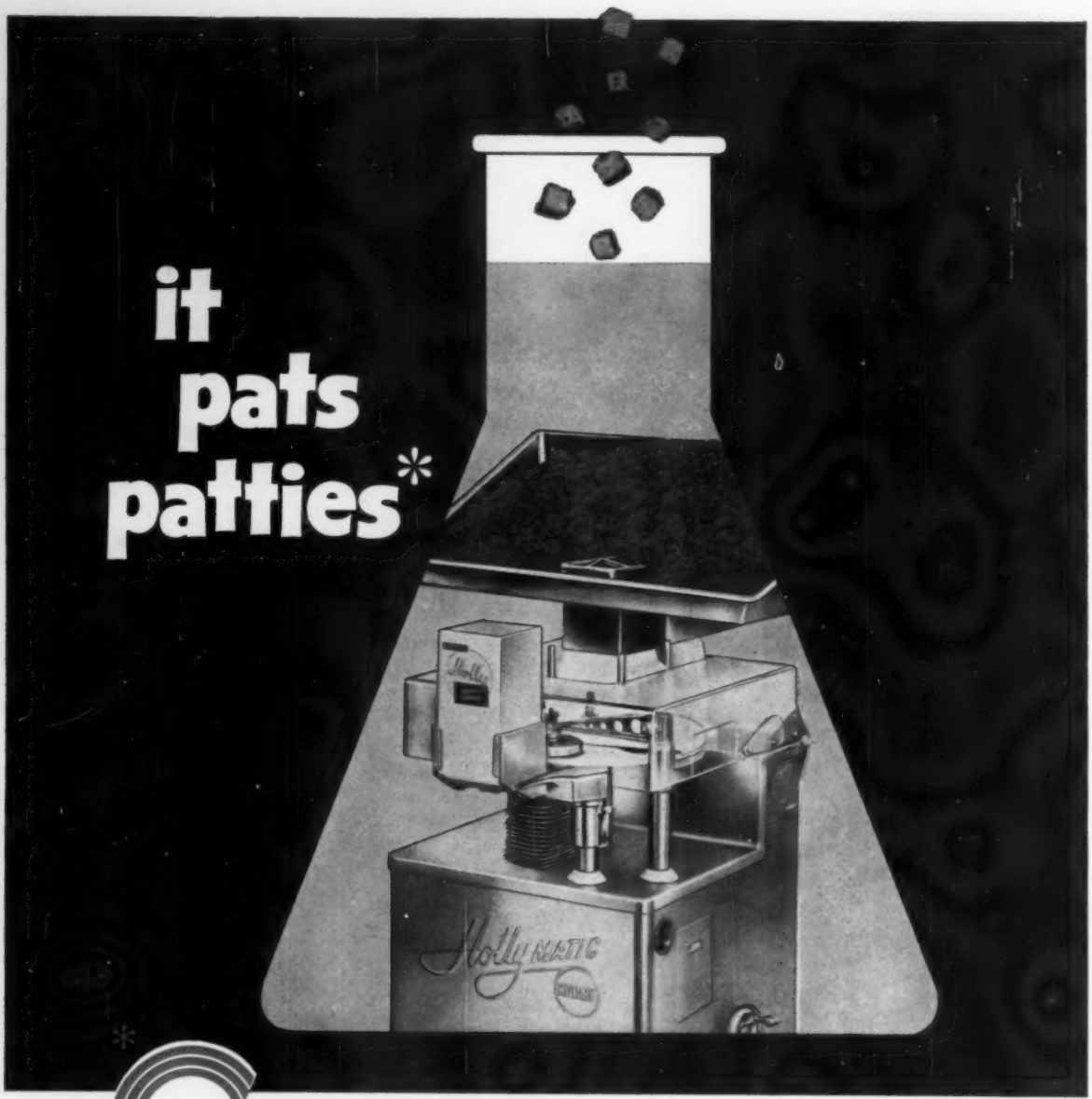

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For their remarkable Rotary Meat Patty Forming Machine, the Hollymatic Corp. of Chicago, Ill. specified CYCOLAC brand plastic for nine vital mechanical parts. Turning out 3600 patties per hour—*continuously*—these parts are under constant stress and strain. CYCOLAC brand plastic proved it could take it—and then some. It provides toughness, dimensional stability, rigidity, stain resistance, toughness; is easily cleaned even in very hot detergent solutions. *Received acceptance for use by M. I. D. (Meat Inspection Div., Dept. of Agriculture) and the F.D.A. (Food and Drug Adm.)* By replacing expensive steel with economical molded plastic, material and production costs were drastically cut. Proof again that CYCOLAC brand polymers are better in more ways than any other plastic. Get the facts . . . write Dept. O-10.

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editorial: STANDARDS AND POLICING

Scarcely a day passes when someone in the plastics industry doesn't speak out for standards—standardization of machinery parts, standardization of terms, quality standards, and test standards. The word policing, however, seems anathema. Instead of considering it a means of protection, it has come to imply persecution and interference.

It's all well and good to speak out for freedom. What many of us forget, though, is that we are living in a society —not a jungle. Someone has to look out for the interests of its members. Much better a self-imposed policing, therefore, than one which is thrust upon us.

The same situation exists in industry. Many of the older industries established their standards of quality before the turn of the century. They have also set up their own policing within their industries, making it unnecessary for outside agencies to force it on them. This policing is done by those familiar with the industry; its problems, limitations, and potentials.

Only one segment of the plastics industry has come around to this thinking, and we think they deserve a lot of credit. This group is made up of material manufacturers and fabricators of potable plastic pipe. The activities of this group is described in some detail in an article running this month; however, I feel it worthwhile to lift some of the details "out of context" which I think could be alterated to suit the needs of other segments of the plastics industry.

Twenty seven resin producers and 64 pipe fabricators (90% of the industry) have signed annual contracts with the National Sanitation Foundation for product supervision and control. Repeated plant inspections are made; random samplings are taken by cooperating State and local health officials; and routine chemical and physical tests are made by the nSf laboratory—both on products and their constituent materials. The nSf seal of approval can be withdrawn at any time for failure to maintain required standards.

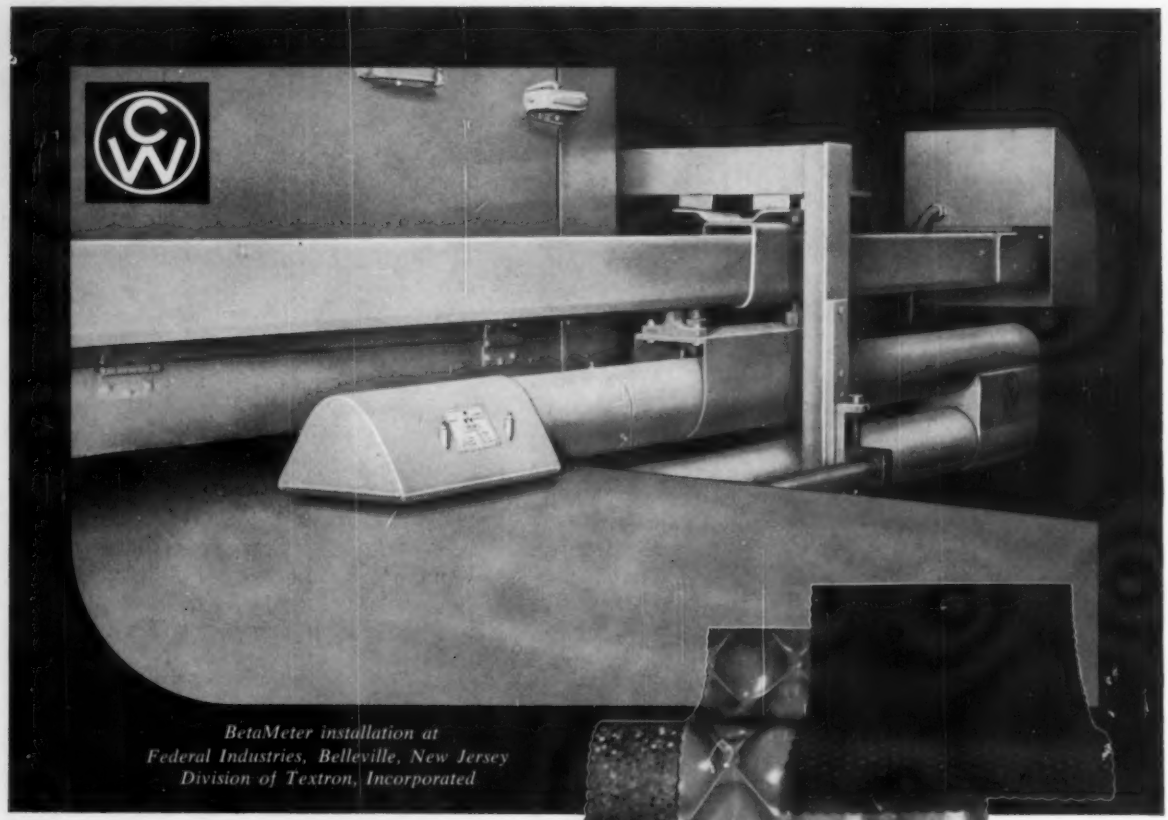
I don't know how many of you have noticed the beating plastic products are taking lately in the syndicated columns of newspapers by self-confessed authorities on the "good life." A lot can be written off to the "nostalgic thinking" which seems to predominate columns of late—the good old days.

But all of this sneering at plastic housings, plastic packaging, plastic housewares, toys, and the like cannot be dismissed so lightly. There are many legitimate complaints about the quality of plastic products—and they are not based on improper design or material choice. The product is poorly made and the material so filled that any parts inspector worthy of the name would reject it immediately.

There is only one way to combat this. Responsible plastics manufacturers must impose a form of policing on themselves to ensure and increase public acceptance of its products. The plastics pipe industry has already done it, why not others?

Jim Dugan

Editor



BetaMeter installation at Federal Industries, Belleville, New Jersey Division of Textron, Incorporated

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BETAMETER® CONTROLS COATING . . . ASSURES UNIFORMITY AT FEDERAL INDUSTRIES

BetaMeter at Federal permits operator to adjust and control variables for each coating specification.

Excellent quality control contributes to Federal Industries' position as a leading manufacturer of plastic coated upholstery fabrics for the automotive industry. To help maintain this rigid quality standard, Federal depends on the Curtiss-Wright BetaMeter for consistent, uniform coating applications on every run.

The BetaMeter, by means of radioactive isotopes, accurately and instantaneously measures coated stock without contacting the material or affecting the process in any way. Variations from proper thickness are instantly shown on a target meter and chart recorder. Corrective adjustments can be made during production runs easily and positively, thereby saving costly raw materials and time. The BetaMeter monitors coated stock continuously, maintains quality control and greatly reduces scrap losses.

Automatic process control equipment is available for all standard BetaMeter measuring systems.

For complete details on how Curtiss-Wright BetaMeter can benefit plastic film, sheet or coated stock manufacturing operations, phone SWinburne 9-0500 or write.

Curtiss - Wright Mark II BetaMeters, for handling up to 36" webs, are priced from $4985 (Strip-chart recorder included).

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talks D-M-E ECONOMY to the Mold Maker and Molder

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D-M-E standard components are fully interchangeable: Replacements can be made without special fitting or reworking. Cavity plates and components can easily and quickly be removed and replaced in perfect alignment.

Whether for injection or compression molding, D-M-E Standard Mold Bases enable you to work with greater flexibility by providing a selection of over 7,000 cataloged mold base combinations! And D-M-E Master Layouts enable designers to devote more time to cavity layout.

MOLD MAKER: D-M-E first-quality carbon or alloy steel assures easier and more reliable machining. And D-M-E Standard Mold Bases have exclusive built-in features at standard cost: surfaces ground flat and square; patented tubular dowels; one-piece ejector housing; stop pins welded to ejector plate; 33 sizes from 9⅞" x 8" to 23¾" x 35½".

MOLDER: D-M-E Standard Mold Bases and components reduce maintenance. They are carried *in stock* at your local D-M-E Branch ready for quick delivery. You eliminate waiting, cut downtime, reduce your inventory and maintain production schedules. With D-M-E you get supplies when you need them from a single reliable source!

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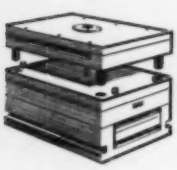

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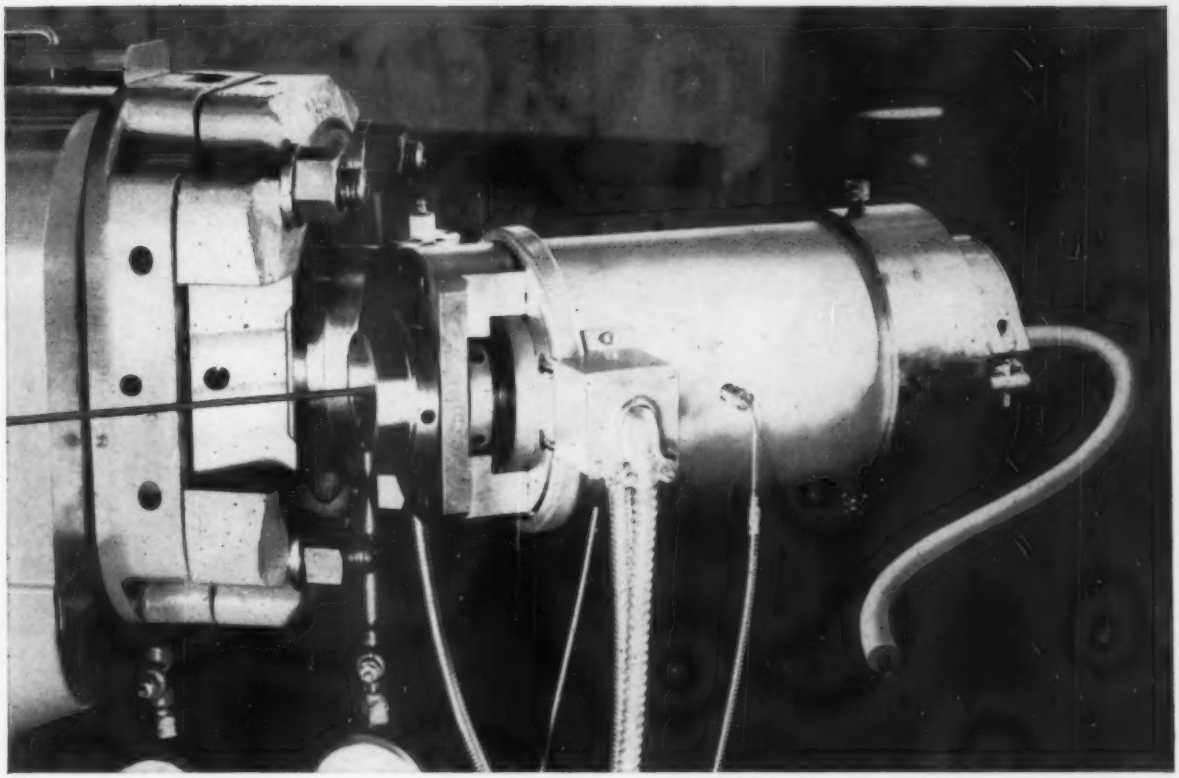

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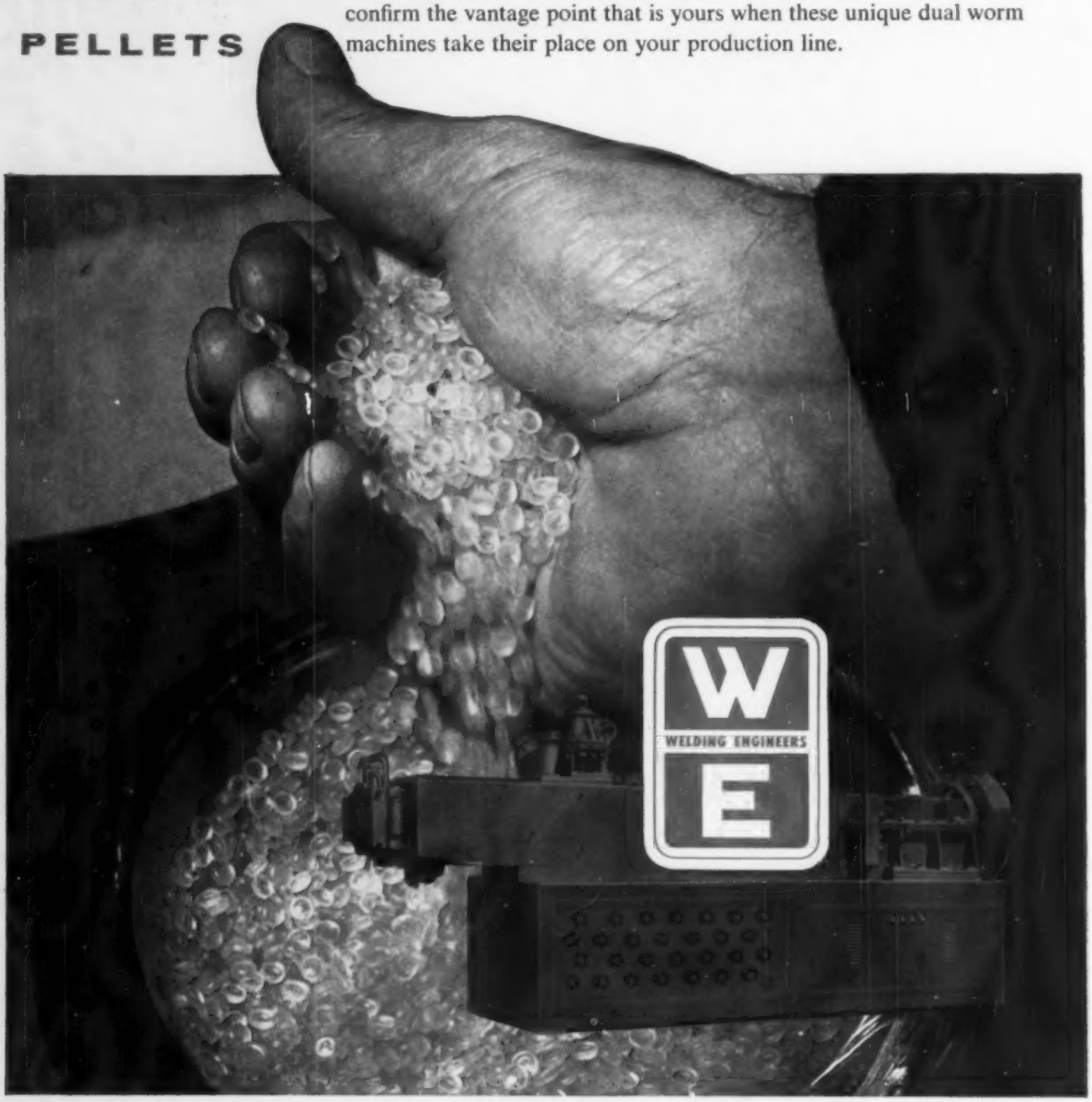

Bright as are the successes of the past 20 years, they cannot compare with the goals set for the future via Welding Engineers dual worm compounder-devolatilizer-extruders. All-in-one operation, continuous, high tonnage . . . **plus quality through-and-through.** When these basic words apply to your own plans for "profits in plastics" it is time to get acquainted with the superiority of Welding Engineers equipment. Extensive laboratory facilities, using your materials if requested, are available to support your new-equipment purchasing judgement.

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Rigid urethane foam— process variables and test procedures

Although this article deals mainly with a specific material designed for low-temperature pour-in-place insulation, it is the most comprehensive work we have seen to date on the processing techniques involved in making urethane foam insulation. Testing procedures seem equally important. The first part of a two part article.—Editor.

Low thermal conductivity is the key to the constantly increasing interest being shown in fluorocarbon-blown rigid urethane foams. Commercial applications already include both appliance and reefer insulation. As acceptance grows, so does the need for improved fabrication techniques.

Rigid urethane foam is applied as slab stock or by pour-in-place techniques. With slab stock, foam is made in large buns which are cut to size and shape for fitting a prepared cavity. With the pour-in-place method, a predetermined amount of liquid chemicals is poured (after mixing) into the cavity. While many sections of this paper apply to both techniques, it deals primarily with the latter method.

Economic factors require that the density of rigid urethane foam insulation be kept to a minimum—about 2 lbs/cu.ft. At this density, the fabrication method becomes more critical, especially as it concerns dimensional stability.

We are mainly concerned in this paper with application of low-density, fluorocarbon-blown, rigid urethane foam as thermal insulation for pour-in-place application. It is a summary of work carried out in Nopco's plastics division laboratories to achieve greater insight into rigid foam technology. As a result of our studies, the following concepts were established:

1. A series of lab-scale tests for foaming systems under standard conditions was devised which permitted measurement of physical quantities similar to those found in panel applications. These tests proved useful as control tests, and invaluable as tools for studying the chemical and physical process variables. They also served as a basis for predicting foaming behavior under commercial application. An SPI applications task group is currently active in establishing standard procedures for lab-scale tests similar to those described herein.

2. The effect of several process variables on physical properties of the final foam panel was shown. The lab-scale tests again provided the key to these relationships.

3. A prototype technique was established whereby the important process variables were controlled in actual parts. In this way, panels fabricated under optimum conditions were obtained and good replication was realized through adequate process control.

To illustrate these concepts, a Nopcofoam system, H602 (one of a series of "H" foams), was used throughout. Studies of other formulations have shown, however, that the basic technology and procedures described herein are generally applicable to any fluorocarbon-blown rigid urethane foam.

Urethane foam characteristics

Urethane foams are thermosetting cellular materials obtained by reacting diisocyanates with comparatively low molecular weight polyols containing active hydrogen. Basically, two reactions are involved: polymer formation and evolution of a gas to produce foaming activity. Nopcofoam H602 is formulated with a polyether base resin and uses a fluorocarbon expanding agent. It is

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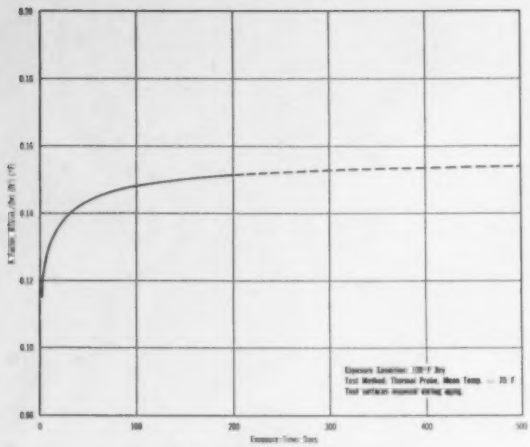

Fig. 1. Effect of aging on K factor.

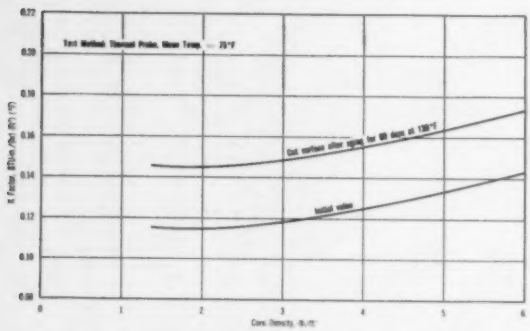

Fig. 2. Approximate relation of K factor and density.

Fig. 3. Approximate relation of initial K factor and mean temperature.

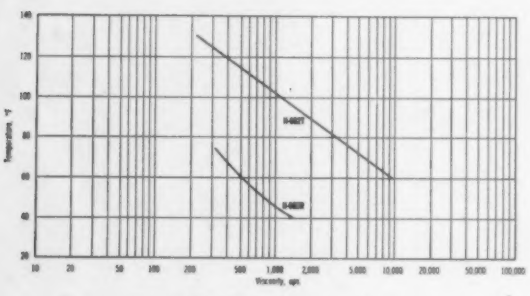

Fig. 4. Viscosity vs. temperature.

supplied as a 2-component system—an R component and a T component.

A prepolymer is obtained by combining part of the polyol and the diisocyanate. When actual foam production is desired, the prepolymer is reacted with a polyol containing the blowing agent. By combining these components at the site, an exothermic chemical reaction is initiated and the heat generated is used to vaporize the dissolved fluorocarbon. The foam rises and seeks out all corners of the mold during its expansive surge, and the blowing agent remains trapped within the multiple cell walls.

The system is self-curing under ambient conditions, although higher mold preheats are recommended. The low final K Factor, good dimensional stability, and low moisture pickup make it especially suitable for refrigeration purposes. It also possesses excellent electrical properties, has machinability, takes coloring additives, and adheres to most materials.

LOW K, LOW COST. The initial K Factor of H602 is 0.115, about half that of most conventional products. Final K Factor, under the worst conditions of aging, is about 0.155. This enables the user to double the insulation at the same thickness or maintain the same insulation at half the thickness. The first alternative means lower cost outlay for insulating equipment and less operating time for the refrigeration units. The second alternative means weight savings and consequently higher payloads.

DIMENSIONAL STABILITY is of special interest since panel core densities down to 1.75 lb/cu.ft. are stable at subzero temperatures. This condition makes possible an overall density of 2 lb/cu.ft. for a 24 x 24 x 2 inch thick panel in a vertical rise. Up to this time, overall panel densities of 2.5 lb/cu.ft. have been required for low temperature stability.

LOW MOISTURE PICKUP. Many insulating materials absorb moisture, thus becoming heavier and less efficient as insulators. Increased weight reduces permissible payloads, and the moisture causes rust and corrosion within the truck or insulator body. Pour-in-place foam tends to seal defects in the moisture barrier while retaining insulating qualities. Cleanliness and lack of odor is maintained—important features in food containers.

Physical properties

Selection of a foam system at minimum density depends principally on the maximum allowable K Factor and dimensional stability. For certain applications, other properties such as compressive strength and water vapor transmission may also be important.

In giving physical property data, it is necessary to list the foaming conditions as well as the configuration of the part and the location of the specimens. The data given in Table 1 were obtained from a vertically poured panel, 24″ x 24″ x 2″. The recommended processing conditions which were used are as follows:

R component temperature	60 ± 2° F.
T component temperature	90 ± 2° F.
Final mold surface temperature	140 to 160° F.
Mold restraint	Total with 10-15% packing
Mold cycle time	15 min.

The actual sequence of events that take place in preparing a panel is given in the section entitled Pouring the Prototype. Here, attention is given to process controls to assure a valid prototype.

K Factor

K Factor is defined as the time rate of heat passing through a unit thickness, across a unit area, and for a unit difference of temperature. It is usually expressed in BTU-in./(hr.) (ft.^{2}) (°F.). The insulating field is naturally after the lowest possible K Factor. Unless otherwise noted, all K Factors in this booklet are reported for a mean temperature of 75° F.

The insulating value of any low density material depends on the type of gas in the cells. The initial K Factor of a 2 lb./ft.^{3} urethane foam with CO_2 in the cells is about 0.22, whereas the initial K Factor of a 2 lb/ft^3 urethane foam with fluorocarbon F-11 is about 0.11. Although the cell walls of H-602 are, for practical purposes, impermeable to the fluorocarbon, some other gases such as air (nitrogen) and water vapor pass through the cell walls with comparative ease. The K Factor at any given time will depend on the mixture of

Table I

GENERAL PHYSICAL PROPERTIES OF H-602

The average values reported should be interpreted as having a range of ±10% and apply to foam processed under the described conditions.

Property	Skin to Skin	Core*	Procedure	
			Nopco	ASTM
Density, lb/ft^3	1.95	1.80	LP-3P-A	D-1622-59T
K Factor, (75° F)			LP-30P	—
Initial	—	0.115		
Final	—	0.155		
Compressive Strength (@ 10%), lb/in.^{2}			LP-4P-B	D-1621-59T
Perpendicular to foam rise	20	22		
Parallel to foam rise	31	28		
Modulus of Elasticity, lb/in.^{2}				
Perpendicular to foam rise	500	—	LP-4P-B	—
Parallel to foam rise	800	—		
Closed Cell, %	—	95**	LP-19P-A	—
Water Vapor Trans., perms			LP-35P	—
73° F, 50% R. H./73° F, 100% R. H.	—	2.5		
Water Absorption, lb/ft^2			LP-7P-4	—
24 hrs, 10 ft head	—	0.05		
Coefficient of				
Linear Expansion, per ° F	—	3.5×10^{-5}	—	D-696-44
Flammability			LP-14P-C	D-1692-59T
Burning rate, in./min.	—	6		

*For all core specimens a ½ inch trim was taken at all skin surfaces. The overall panel density was nominally 2.0 lb/ft.^{3}

**Closed cell value includes cell wall.

DIMENSIONAL STABILITY

Dimensional stability values are reported as a percent. Positive values indicate expansion. The values reported are the average of four specimens taken at random from a single panel and should be interpreted as having a range of about ±10%. The specimen size is 2" x 2" x 2" for skin to skin values (including one edge), and 4" x 2" x 1" for core specimens (½ inch trim on all sides).
Linear change value is reported for the worst direction, normally perpendicular to foam rise. The overall panel density was nominally 2.0 lb/ft.^{3}

Exposure Time	Atmospheric Condition	DIMENSIONAL CHANGE, %				Procedure	
		Skin to Skin		Core			
		Linear	Volume	Linear	Volume	Nopco	ASTM
24 hours	0° F, dry	> —0.2	> —0.2	> —0.2	> —0.2	—	—
24 hours	160° F, dry	< 0.2	0.4	< 0.2	< 0.2	—	—
24 hours	180° F, dry	3	6	0.6	0.7	—	—
24 hours	110° F, 100% R. H.	3	8	2	3	LP-35P	—
24 hours	160° F, 100% R. H.	10	25	12	25	—	—

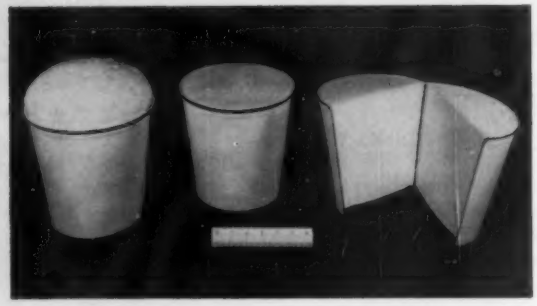

Fig. 5. Optimum excess of foam before cutting (left), excess removed for final weighing, and cup split open to inspect foam structure.

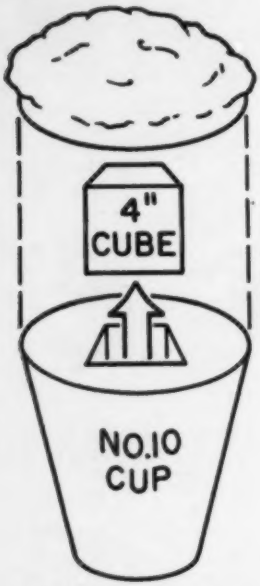

Fig. 5a. Control cup core density in lb ft^3 for a 4-inch cube cut into the top surface of the cup. Crown has already been trimmed.

gases in the cells. If gases are allowed to infuse they reach an equilibrium point when the partial pressure of each gas in the cells is equal to its partial pressure in the atmosphere. It is this infusion of gases that accounts for the drift in K Factor from 0.115 to 0.155, as shown in Fig. 1.

If a protective covering, such as a metal skin, prevents gas infusion, then the initial K Factor remains without drift. Because the diffusion of air (principally nitrogen) takes place over a period of weeks, a K Factor gradient exists at a cut surface during this time. A 2-inch thick specimen aged at 130° F. for 60 days will show a K Factor drift at the surface, but will still retain its original K Factor in the center.

The choice of K Factor value in design depends on the kind of barrier provided against gas infusion and the service life of the item. Until long-term K Factor drift data for urethane foams in specific items are available, it is recommended that the final K Factor of 0.15-0.16 be used as a design criterion. However, if the fabricator uses an effective vapor barrier and checks to see that no appreciable drift takes place, the initial K Factor can be used.

In addition to the gas in the cells, K Factor is influenced by density as shown in Fig. 2. It may be noted that in the range of 1.5 to 2.5 lb/ft^3, the K Factor is relatively constant. Below this range, it tends to rise due to coarse or open cells. Above this range, the higher K Factor of the solid polymer begins to raise the foam K Factor.

Because K Factor depends on temperature, the average temperature at which the K Factor is obtained must be given. This effect is shown in Fig. 3. In designing an insulator, the average of the operating surface temperatures may be used to relate the application to Fig. 3.

Water vapor transmission

As reported in Table 1, H-602, as with all plastic foams, has a finite water vapor transmission rate, which is 2-3 perms. This is important to low temperature insulation since water vapor tends to migrate to the cold surface. Water vapor or icing in extreme conditions increases the K Factor. Although H-602 is a vapor barrier to a degree, an added vapor barrier, such as a metal skin, should always be on the warm side of the insulator.

Dimensional stability

Dimensional instability for low density foams may result from two effects. The normal expansion of the polymer due to temperature change is expressed by the coefficient of thermal expansion as given in Table 1, 3.5 x 10^{-5} per °F. In addition, there can be dimensional changes due to differences in gas pressure between the cells and the atmosphere. At low densities, differences in these gas pressures can be of the order of magnitude of the compressive strength of the foam. At sub-zero temperatures, the fluorocarbon F-11 is partly condensed making its partial pressure only about 2 lbs/in^2 in comparison to the atmospheric pressure of 14.7 lb/in^2. This pressure difference tends to collapse the foam. At higher temperatures, a pressure in excess of atmospheric is created tending to make the foam expand. Although the pressure difference is not as large as the sub-zero differential, the softening effect of temperature can result in expansion.

High humidity tends to plasticize the foam, causing a loss of strength. High temperature and humidity result in a more severe exposure than just high temperature. All evidence to date indicates that the foam returns to its original strength when the moisture is removed from it.

The exposure conditions and specifications for urethane foam insulation are still tentative. A Society of the Plastics Industry Committee is active in setting up industry standards. At present, the conditions discussed by the committee include 0° F., 160° F. dry, 180° F. dry, 110° F. at 100% R.H., and 160° F. at 100% R.H. Data under these exposures are shown in Table 1. In interpreting these data, the maximum allowable expansion or shrinkage under the conditions experienced by the foam in the application is taken as 2% or less on linear dimensions.

This applies especially to the stability at low temperature (0° F.) and high temperature (160° F.). The requirements on more stringent tests such as humid aging depend on the application, and are often used as a screening test rather than a performance test. Since dimensional stability depends on the relation of foam strength to internal cell pressure, stability generally

improves as density increases. The tougher the exposure conditions, the higher the density must be. In order for this density relation to be valid, proper fabricating techniques must be used. (See—Pouring the Prototype.)

Chemical components

To permit foam production on your site, H-602 is separated into two components—R and T in a 46:54 ratio. Component R is a clear, dark amber liquid of low viscosity, containing the resin and the fluorocarbon F-11 blowing agent. Component T is a clear, light-colored material containing the prepolymer and the balance of free isocyanate.

Component viscosities are given in Fig. 4. The fluorocarbon-containing resin is shown only below 75° F., since its use above this temperature is not recommended. Storage life in tightly sealed containers is six months when stored at the recommended temperature.

The most likely cause of "high" control density is loss of the fluorocarbon prior to mixing. Because of its volatile nature, fluorocarbon-content loss may occur due to improper handling, especially in prototype development stages. If this happens, the R/T ratio will be incorrect and the density and physical properties will deteriorate. Fluorocarbon can be added after such a loss, but a simple test is needed to check the adjusted content. This test, described in Appendix I, consists of obtaining the specific gravity of the resin with a hydrometer and using the temperature curve to check fluorocarbon content. The test is fast, nondestructive, and easy to run in the field. Its use is essential before any pour is made, particularly when the volatility of the fluorocarbon is high (at concentrations of 25% or more and at temperatures above 75° F.).

The dissolved fluorocarbon also helps lower viscosity of the components, making it easier to mix and pour. The viscosity is lowered for two reasons. First, the fluorocarbon itself has a low viscosity at room temperatures and therefore lowers the component viscosity by dilution. Secondly, the fluorocarbon has a high heat of vaporization and absorbs some of the heat generated as the components react. Gelling of the reactant mass is delayed and the foam system remains more fluid during the rise, reducing shear along the panel walls.

Density and foaming characteristics

A foaming system goes through several physical changes as it becomes a solid material. These include temperature, volume, pressure, and weight. This section gives qualitative and operational definitions to density and foaming characteristics for H-602. Reference is made to the appendix for exact definitions and detailed or abstracted test procedures. The values for H-602 obtained by these procedures are given in Table 2.

Because of the importance of density as a control test, a special procedure has been written by the Nopco Laboratories (See Appendix II). Through the use of this test, density can be determined within a range of about 5%. As a result of pouring a specified amount of foam in a No. 10 cup, a foam is obtained as shown in Fig. 5. After the top excess is trimmed, a control cup density is obtained representing the material left in the cup. In development work a control cup core density is also obtained (See Fig. 5a). The latter value is less affected by ambient conditions because of the trim taken from the edges. It is recommended that control cup density

Table 2

H-602 FOAMING CHARACTERISTICS UNDER STANDARD TEST CONDITIONS

Control Density	
Cup Size	No. 10
R/T Weights	97 gms/113 gms
Mix Time	15 sec.
Cup Density	1.55-1.65 lb/ft³
Cup Core Density	1.45 lb/ft³
Rise Rate	
Maximum Handling Time	0.6 min.
Rise Time	3.6 min.
Tack Free Time	5.5 min.
Temperature Rate	
Maximum Temp.	300° F
Time to Max. Temp.	7 min.

Values Reported and Their Significance:

1. All data reported as a single number should be interpreted as having a range of ±10%. Statistically, this would correspond to 95% confidence limits.
2. All data are obtained with the average temperature of the components 72-76° F just prior to the start of mechanical mix.
3. Time = 0 taken at the start of the mix.
4. Cup Density = 0.0113 W lb/ft³ for a No. 10 cup.
   Where W = net weight of foam in grams in trimmed cup.
   Cup Core Density = 3.81 W/V lb/ft³ for a 4 inch cube.
   Where W = weight of cube in grams.
   V = volume of cube in in.³

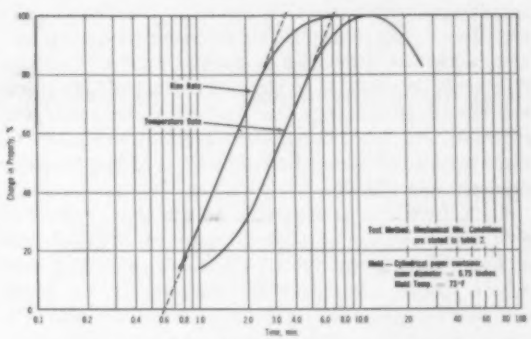

Fig. 6. Rise and temperature rate curves.

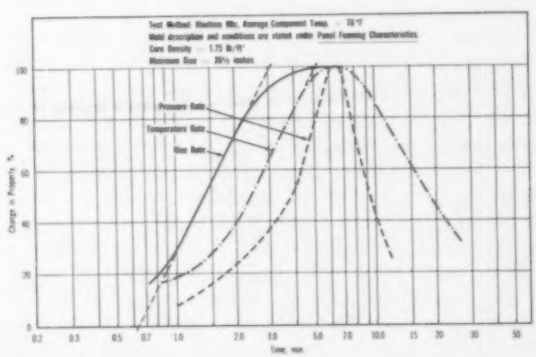

Fig. 7. Pressure, temperature, and rise rates for an unrestrained rise.

values be obtained frequently during development and at regular intervals in production.

As a foam rises its apparent weight decreases. The weight loss not only follows the volume expansion, but is equal, within experimental error, to the weight of air displaced. Thus, the weight loss is due to the buoyant effect of air and is equal to the density of air, 0.08 lb/ft³ (at 75° F.). For example, a foam reported by ASTM D-1622-59T, Apparent Density of Rigid Cellular Plastics, as 2.0 lb/ft³ has an actual density of 2.08 lb/ft³.

Rise rate values

Maximum handling time, rise time, and tack free time are given in Table 2. The rise rate curve from which these values were obtained is shown in Fig. 6. An abstract of the defining experiment for rise rate values is given in Appendix III.

Maximum handling time is that period during which a batch mix can be poured, or the length of time for dispensing from machine to cavity. The maximum handling time corresponds to the initiation of foaming action and about 10% expansion. For standardization, all handling times are reported with time equals zero at the start of the mix. Dispensing of the foam must be completed within the maximum handling time because freshly mixed material poured onto foaming material upsets the cell structure, and if the dispensing time should approach the rise time, parts of the foam will have hardened thereby restricting the expansion of the material still foaming. The handling time value of 36 seconds for H-602 should be considered maximum.

Rise time is that period corresponding to about 90-95% of the rise height of a foaming system. For standardization, all rise times are reported with time equals zero at the start of the mix. The rise time is useful as a control method on the rate of reaction, and also in predicting foaming characteristics. Sufficient rise time must be available to close or cap a mold. In using the rise time values, adjustment must be made for crowning and 10-15% packing. The fill time (time to reach access hole) may be estimated as ⅓ less than the standard rise time.

Tack free time corresponds to the time when the crown of the foaming system may be touched lightly with the fingers without stickiness. As with rise rate values, time equals zero at the start of the mix. Tack free time is used widely as a measure of reaction rate. While it may be useful as a control measure, it seems to bear no direct relation to any foaming characteristic such as cure rate or mold cycle time.

Temperature rate values

The temperature rate test is perhaps the best indication of reaction rate. The time to maximum exothermic temperature when multiplied by a factor is used as a basis for establishing a theoretical minimum mold cycle time. The temperature rate curve from which this value is obtained is given in Fig. 6. The maximum exothermic temperature for H-602 is 300° F. It is the maximum temperature that can be realized regardless of cross section, and is obtained in cross sections of about 6-8 inches or greater. The maximum exothermic temperature of 300° F. does not cause discoloration of the foam in 24-inch cross sections. The exothermic temperatures are useful in estimating temperatures encountered by encapsulated parts, and as a method of control. For higher densities, the exothermic temperature may be used to anticipate discoloration due to high temperature.

Panel foaming characteristics

Certain aspects of a foaming system are quite different within a panel. Skins tend to hold back or restrict foam rise as well as dissipate heat from the foaming system. In order to study the results of these conditions in a panel, measurements of rate of rise, temperature, and pressure may be made in unrestrained and restrained rises. A 24″ x 24″ x 2″ (inside diameter) wooden mold preheated to 130° F. was used for a vertical rise. The experimental technique is described in Appendix III. The curves obtained for H-602 in an unrestrained rise, are given in Fig. 7.

Due to heat loss from the foaming system to the panel facings, the maximum temperature reached in the center of a 2-inch thick foam is 245° F., as compared to the maximum exothermic temperature for H-602 of 300° F. Both the rise time and time to maximum temperature are shorter than the standard foaming characteristics. This is again due to heat loss to the skins. Because heat is lost even as the foam rises, an apparent maximum occurs when the rates at which heat is generated by the reaction and lost to the skins are equal. The effect of the heat dissipation on density and mold cycle will be discussed later.

It is especially interesting to relate the pressure experienced by the mold to the rise and temperature rate curves. The maxima occur at the same time. This indicates that for a final mold surface temperature of 145° F. the final stages of expansion are due to temperature. When the temperature has reached its maximum, the rise height and mold pressure have also reached their maximum.

A further phase relation occurs between the rise and pressure rate curves. Substantial pressure build-up occurs after about 85% of the rise. This fits the qualitative observation that, up to this point, the foam is very fluid. Beyond 85% rise, the viscosity increases rapidly, causing sufficient resistance to rise so that pressure is built up against the mold surfaces. The maximum pressure for the unrestrained rise is 0.17 lb/in².

As the foam goes through this rapid gelling action, the effect of mold surface on foam motion becomes more pronounced. At this point considerable shearing action takes place at depths up to ½-inch from the skin surface. This shear results in cell elongation at the surface, especially at the top of the rise. For low density foams in the range of 2 lb/ft³ this cell elongation is very serious because it reduces the compressive strength perpendicular to cell elongation. This results in poorer dimensional stability in the sheared areas than in the core of the panel.

To take advantage of the fluidity of the system up to 85-90% of the rise, and avoid the extreme shear conditions encountered in panels at the end of the rise, restraint is used. That is, an extra amount of material is included in the charge and the excess is prevented from leaving the mold. This is called packing.

Packing results in increased mold pressures. The mold pressure is about equivalent to that which would be obtained by treating the foam as a gas and pushing the excess volume back into the mold. The pressure due to the recommended 10-15% packing has been measured in restrained molds and is about 1.5-2.0 lb/in², as compared to only 0.17 lb/in² for an unrestrained rise. At 30% packing the mold pressure is about 4 lb/in². Since this pressure is a significant fraction of the compressive strength of low density foams, the high temperature dimensional stability is affected by the amount of packing or mold pressure.

This leads to a fundamental concept in processing panels of low density urethane foams: that of optimum packing. If too little packing is used, foam shear results in poor dimensional stability, especially at low temperatures such as 0° F. Also, no allowance is made for manufacturing variations. If large amounts of packing are used, high temperature stability becomes worse, especially under humid conditions.

Density distribution studies show that the panel core density is nearly independent of all mold conditions except for packing. This is because large density gradients in a 2 lb/ft³ foam do not penetrate more than half an inch, even under the worst conditions. Since the panel core density is determined after trimming off this half inch, it can be related to the cup core density as long as the cross section of the panel is 2 inches or over.

The fact that the core density remains relatively constant leads to the important concept of application prototypes. Given a satisfactory foam in a standard 2-inch thick mold, this same formulation can be used in a variety of applications with cross sections of about 2 inches or over. With such wide applicability, a tested formulation can then serve as a prototype for other uses. Preparing a prototype will show the correct charge and overall density to be expected under actual manufacturing conditions.

Pouring the prototype

To demonstrate the use of the standard foaming characteristics as well as the process conditions described in following sections, casting of a panel under the recommended process conditions is given here. One purpose is to provide a pattern around which prototypes for other types of castings can be planned; another is to provide a focal point around which to integrate the various process variables. Only by starting with a set of optimum conditions can the effect of the variables be presented in a logical fashion. Also, by resorting to optimum conditions, the application of urethane foam is greatly simplified.

The general process techniques given here are expected to apply to any fluorocarbon F-11-blown rigid urethane foam. Although the actual processing values may require adjustment for different formulations, the concepts appear generally applicable. Initial experiments with frothed foams indicate they too will fit the broad concepts.

A prototype under the exact manufacturing conditions is considered a necessary step for each new item. This is due to the number of process variables associated with the shape and handling of the part. Also, a prototype is necessary to obtain the physical properties of the specific part. Once a valid prototype has been tested and accepted, actual production controls vary for different applications. The extent of control depends on the final properties required. In general, two foam controls are needed. One control covers the density and cell structure in a test pour; the other measures the extent of fill or packing. These are demonstrated by the control cup density and mold deflection in the following illustration.

A vertically poured panel of H-602, 24″ x 24″ x 2″, is used. The objective is to obtain a panel for appliance insulation whose density is just over the threshold required for dimensional stability. Broadly, we must prepare a mold, and cast at least two panels in it. The first panel will be an unrestrained foam rise to determine the correct charge for the final panel, which will be a restrained foam rise.

Mold preparation

Wood was picked as the material of construction due to the ease of fabrication and low cost. The mold was designed so that the facings would deflect as a plate and the center deflection of each facing would be about 10-15 mils at the anticipated foaming pressure of a 2 lb/in² (corresponding to 10-15% packing). A 1-mil dial gage was mounted as shown in Fig. 8 to measure deflection. A sandwich construction was used consisting of ½-inch plywood facing and a core of fir strips 1⅛ inches thick x ¾-inch wide on 6-inch centers. Two-inch thick shims were placed between the sandwich panels. Provision was made for removing the top edge for an unrestrained rise and for plugging a 1-inch diameter access hole in the center of the top edge for a restrained rise. Air escape holes ⅛-inch in diameter were placed in the top corners of the mold. Oven facilities for preheating the mold to 130-140° F. were available, and the inside surface temperature of the mold was measured with a thermocouple. The inside surfaces of the mold were covered with brown paper and then waxed so that the foam would release from the mold.

Here are the panel density terms; Overall panel density is the density of an entire panel including all 6 skin surfaces, in lb/ft³.

Skin-to-skin density is the density of a section taken from the panel having 2 parallel skin surfaces with at least 1 inch trimmed off all other sides, in lb/ft³.

Skin density is the density of 0.1-inch of skin surface taken from the skin-to-skin density specimen, in lb/ft³. If specified, other thicknesses may be used.

Panel core density is the density of a panel core remaining after 0.5-inch trim has been taken off the skin surface of the skin-to-skin density specimen, in lb/ft³.

Calibration of components and machine

H-602 R and T components were charged into a machine whose output was 15 lb/min. The R component is precooled to 70° F., and the components were circulated in the machine until a temperature equilibrium of 60 ± 2°F., for the R and 90 ± 2°F., for the T component was reached. Following temperature equilibrium, the specific gravity of the resin was taken. The specific gravity was found to be 1.191 and the temperature 61F. Referring to figure 14 in Appendix 1, this falls within the acceptable range at 61°F.

The machine was then calibrated so that the weight of material delivered was within ± 1% of the correct amount. This was accomplished by removing the mixing head and dispensing both components simultaneously into paper cups. The fixed output side was the T component. A 10-second shot resulted in 1.35 lbs. of T component. For an R/T ratio of 46/54 the correct amount of R component was 1.15 lbs. The ± 1% accuracy required that the R component be within ±0.01 lbs. of the correct value, 1.15.

The mixing head was then placed on the machine and a control cup density obtained. As given in Table 2, a 210-gram shot is required. This corresponds to 1.85 seconds on the machine timer. The cup is allowed to foam and a qualitative rise time of about 3 minutes obtained. When the foam has set, the excess is removed and the cup density obtained. The resulting value, 1.59 lb/ft³. The cup was split in half and the core examined for fine uniform cell structure.

Unrestrained rise

In preparation for the unrestrained pour, an estimate of the required charge to fill the cavity is made. From prior knowledge of density distribution, it was expected that a final overall panel density of 2 lb/ft³ (including 10-15% packing) could be realized. Since:

Weight = density x volume
Where density is given in lb/ft³, volume is given in ft³, and weight in lbs.

Then weight = 2 lb/ft³ x 0.667 ft³ = 1.33 lbs.

The mold with the top edge removed is taken from the oven and set in place for filling. A check of the thermocouple on the inside surface of the mold indicated a temperature of 132°F., which falls within the specification of 130-140°F.

A quantity of material equal to 1.33 lbs. (5.32-second shot) is dispensed into the unrestrained mold. As the foam rises in the panel, a second control cup density is poured. This density is 1.61 lb/ft³, which is within experimental error of the first cup and also within the specification. Inspection of the core indicated a fine uniform cell structure. The final (maximum) surface temperature of the mold is noted as 145°F. This temperature satisfies the minimum of 140°F., required to realize a minimum mold cycle time. The foam is stripped from the mold after 15 minutes. The excess beyond the inside dimension of the mold is removed. This excess is weighed and found to be 0.10-lb. The charge for 12% packing in the restrained rise is calculated as follows:

Charge (12% packing) =
1.12 x (Weight of Initial Charge—Weight of Trim)
For the illustration:
Charge = 1.12 x (1.33 lb—0.10 lb) = 1.38 lb.

This is equivalent to a 5.52-second shot from a 15 lb/min. machine (the excess should not be more than 20% of the weight of the initial charge).

Restrained rise

Unless the restrained rise can be made immediately through the use of a second mold that is already preheated, the Calibration of components and machine as described above is repeated.

The restrained rise follows the pattern of the unrestrained rise except that the top edge is in place and the access hole is plugged prior to the foam reaching it. Also, the mold deflection is obtained. The mold was removed from the oven, and the inside surface temperature verified. A temperature of 135°R., is obtained which is within acceptable limits. A dial gage was mounted on one surface of the panel and the calculated charge for 12% packing delivered into the mold. The access hole was plugged. During foam rise in the panel, a control cup density was taken. The final surface temperature of the mold is 148°F. The maximum deflection of the mold is 14 mils. After 15 minutes from the start of the mixing, the panel was stripped from the mold.

Panel evaluation

The panel is allowed to set under ambient conditions for 24 hours before evaluating its physical properties. Although extensive testing may be done on the panel, there are several screening tests that are necessary to validate the process conditions.

The following density data in lb/ft³ were obtained for this illustration:

1. Control cup and control cup core densities.
   Control cup = 1.59 to 1.61.
   Control Cup Core = 1.44 to 1.46
   These data are recorded for control purposes.
2. Unrestrained rise and restrained rise panel core densities.
   Unrestrained Rise Core = 1.58
   Restrained Rise Core = 1.78
   These data are obtained to verify the calculated packing. The restrained rise panel core should be about 12% higher than the unrestrained panel core density. If so, then the mold deflection may be taken as representative of the correct packing.
3. Restrained rise panel overall, skin to skin, and skin density.
   Overall = 2.00
   Skin to Skin = 1.95
   Skin = 2.50

These data when compared with density distribution plots, provide a basis for establishing the uniformity of the panel and the consistency of the panel with other data. The discrepancy between the dispensed weight of 1.38 lb. and the apparent weight of the panel (1.33 lb. based on 2 lb/ft³ overall density and 0.667 ft³) is due to the buoyant effect of air. Material cost is therefore better based on dispensed weight rather than the panel overall density.

In addition to the density checks, sections of the panel should be placed in a freezer at 0°F. A 6-inch wide section along an edge parallel to foam rise is recommended. It is important that corners, tops, and edges be included since they are most likely to show shrinkage for low density foams. This is due to the accumulative effects of shear elongated cells) and slightly lower density. The H-602 panel tested in this manner showed less than 1% linear shrinkage after 24 hours at 0° F. The measurement was taken with the foam at 0°F. After this initial screening, other tests may be run and physical property data as shown in Table 1 obtained.

(Continued next month)

EDWARD H. LOOK*

Plastics pipe—a progress report

An outstanding example of cooperation within an industry, and between an industry and its customers in developing quality and performance standards for a product to increase acceptance and markets, is found in this progress report on plastic pipe. These efforts, which began in 1952 with the formation of the SPI Thermoplastics Pipe Division, include continued coordinated activities with certain government agencies, trade associations and technical societies. This article is based on a talk given in May 1961 by Mr. Look before the Water Works Short Course at Oregon State University, but has been updated to the current month by the cooperation of Mr. Look and Bert S. Montell, secretary of the SPI Thermoplastics Division.

During its less than 20 years of commercial production, the annual sales volume of plastics pipe has grown from under $500,000 to an estimated $65,000,000 or more in 1961—a fantastic increase of more than 130 times that of its first year of commercial production. An annual sales volume of more than $100,000,000 is predicted before 1965.

This rate of growth of the production and use of plastics pipe is even more impressive when it is realized that much of this progress was made in spite of rather than because of, the efforts of the plastics pipe industry itself.

Let us consider some of the ways in which progress in plastics pipe in the past was hindered rather than helped by those connected with its manufacture and sales.

First, and for a dangerously long time, all plastic pipe was thought of as merely a product that was "black with a hole in it" and much of it was sold on price alone without concern as to its quality or application. In order to meet competition, some irresponsible extruders thinned down pipe walls without regard to pressure or service requirements, substituted reground "junk" compounds without thought as to either their suitability for pipe extrusion or ultimate pipe use, and in many ways, either intentionally or at least irresponsibly, misled and confused the ultimate buyer of plastic pipe. As a result, many people, particularly professional engineers, waterworks and gas superintendents, contractors and dealers, backed away from plastics pipe or limited its application to non-critical installations.

Second, even the extruders who were conscientiously trying to do an objective and responsible job, both in the extrusion and marketing of their plastic pipe, confused the buying public and thus delayed the acceptance of plastic pipe by the perplexing number of sizes, wall thicknesses, pressure ratings, types, etc., which they offered. All of these various sizes and types had conflicting and overlapping performance specifications and recommended applications with the result that all too often the prospective purchaser, not knowing what to buy, bought nothing.

Third, the resin suppliers, in their zeal to capitalize on the pipe extrusion market, went through a period of introducing new resins for plastic pipe at a rate of practically one every Monday morning, with each week's resin allegedly far superior to the competitor's resin of the week before, and all done with a sales spiel that would have been the envy of the old time carnival hucksters of patent medicine.

In retrospect, with this combination of the equal guilt of the resin suppliers and pipe extruders for the above mentioned irresponsibility, confusion, and sales double talk, it is small wonder that there was more skepticism than confidence during the early days of plastic pipe, even among the extruders themsleves as well as among its distributors, dealers, and ultimately the buying public.

Corrective action—Past, present and future

What have we already done as an industry, both as

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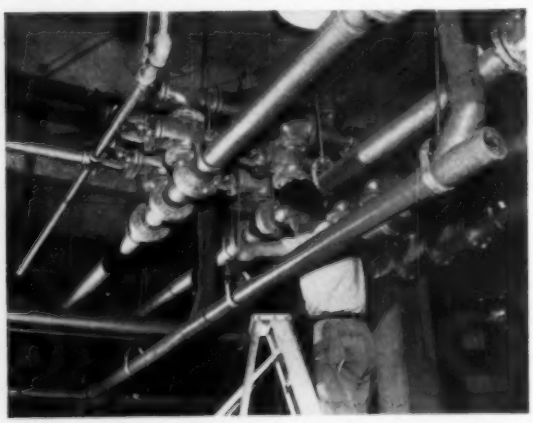
resin suppliers and extruders, and more importantly, what more are we going to do to correct the errors of the past and justify the future potential of plastics pipe?

The answer to the above question is one of the outstanding present-day examples of cooperation within an industry through its trade associations and technical societies, and with the help of certain governmental agencies.

Among the organizations involved in this effort, which began with the organization of the Thermoplastics Pipe Division of the Society of the Plastics Industry in 1952, are the American Waterworks Association, the American Petroleum Institute, the American Gas Association, the Western Plumbing Officials Association, and the State Sanitary Engineers, and public health officials. Also, among the technical organizations participating are the National Sanitation Foundation, the American Society for Testing Materials, the American Standards Association, and the Underwriters' Laboratories. The government agencies include the U.S. Department of Commerce's Commodity Standards Division and National Bureau of Standards, the Federal Housing Administration, the Farmer's Home Administration, the U. S. Navy's Bureau of Ships, and the General Services Administration.

All of these organizations and others, including large chemical companies and individual extruders themselves, have combined their resources in a commendable joint cooperative and objective effort to both develop the full potential of a needed product and, at the same time, protect the buying public in its purchase and use of plastic pipe products.

One of the earliest problems in connection with increasing the acceptance of plastic pipe was the question of toxicity when used to handle potable water, concern about which was quickly expressed by officials of Public Health departments. The plastics pipe industry through the SPI Thermoplastics Pipe Division contacted the National Sanitation Foundation at the University of Michigan and an advisory committee composed of state sanitary engineers, state health officials, representatives of the American Waterworks Association and five members of the plastics pipe industry was established to organize, direct and evaluate studies on this problem, which were carried out over a period of four years. The test program[1] got under way in 1954 and was completed in 1957 with the result that most plastic materials and pipe made therefrom were found to be suitable for underground use in conducting cold potable water. The test procedures for toxicity developed and approved by the nSf enabled it to set up annual contract arrangements with resin suppliers and pipe producers whereby industry companies could use the nSf seal for all materials and pipe meeting the requirements of these tests.



1. Shiny-surface pipe, center, is ABS plastic pipe in use at Elm Fork Purification Plant of Dallas, Tex., Water Department to carry corrosive ferric sulfate. Surrounding pipes are lead-lined pipes.

It was soon agreed, however, both by nSf and public health officials on one hand and by pipe producers and interested professional groups on the other, that the use of the nSf seal, if it were to stand for quality and insure buyer confidence in the way both the industry and the nSf desired, should guarantee performance and dimensional stability as well as freedom from toxicity of both the resin and the extruded pipe. There was little purpose in insisting that pipe be made from virgin, nontoxic resin, if irresponsible extruders were allowed to thin down their pipe walls and in other ways short cut standards in order to obtain a competitive price advantage under the protection of the nSf seal.

The current contracts of plastic pipe manufacturers with the nSf make it mandatory, therefore, that all pipe carrying the nSf seal, in addition to meeting toxicity requirements, must comply with existing or proposed performance and dimensional standards of the U.S. Department of Commerce, Commodity Standards Division, which Commercial Standards[2] were developed with the cooperation of the National Bureau of Standards and the plastics pipe industry.

The nSf has contracts currently with 27 resin suppliers and 64 manufacturers of plastic pipe for the use of the nSf seal,[3] which provide for supervision and control of the quality of the products "Listed." These contracts include provisions for a joint testing progran of the nSf and pipe manufacturers which has been recently strengthened in the following manner: (1) By including inocuous tracer elements in the resin itself to better detect the substitution of off grade material. (2) Repeated and more frequent surprise visits to plants manufacturing pipe and fittings to check production procedures. (3) Increased random field sampling of finished pipe by cooperating State and local health officials to insure compliance with the standards and proper resin use in all pipes carrying the nSf seal. (4) Routine chemical and/or physical retesting by the nSf Testing Laboratory of pipe and fittings, as well as of material used for making these products. (5) Stricter enforcement and penalties for violators by the Foundation for

[1] "A Study of Plastic Pipe for Potable Water Supplies," Walter D. Tiedman and Nicholas A. Milone, National Sanitation Foundation, School of Public Health, University of Michigan, Ann Arbor, Mich. (1957).

[2] CS206-57, Cellulose Acetate Butyrate Pipe
CS218-59, Rigid ABS Plastic Pipe (IPS Dimensions)
CS219-59, Dimensions and Tolerances for Solvent Welded Rigid ABS Plastic Pipe
CS220-59, Dimensions and Tolerances for Lightweight Rigid ABS Plastic Pipe
CS197-60, Flexible Polyethylene Plastic Pipe
CS207-60, Rigid Unplasticized Polyvinyl Chloride Pipe
CS228-61, Styrene-Rubber Plastic Drain and Sewer Pipe and Fittings
CS237-61, Dimensions and Tolerances for Schedule A Type I and Schedule A Type II Rigid Polyvinyl Chloride Pipe (Lightweight PVC Pipe)

[3] "1961 Seal of Approval Listing of Plastic Materials, Pipe, Fittings and Appurtenances for Potable Water Supplies," National Sanitation Foundation Testing Laboratory, Ann Arbor, Mich. Feb. 1, 1961.

those manufacturers with whom it has contracts for use of the nSf seal.

Development of Commercial and Other Standards

What are these Commercial Standards referred to, how are they developed, and what is their connection with similar or supplementary standards developed by voluntary technical organizations in an industry?

Commercial Standards are developed by manufacturers, distributors, and users in cooperation with the Commodity Standards Division of the Office of Technical Services, Business and Defense Services Administration, and with the National Bureau of Standards, both of the U. S. Department of Commerce. Their purpose is to establish quality criteria, standard methods of test, rating, certification and labeling of manufactured commodities, and to provide uniform bases for fair competition.

The major responsibility of directing and coordinating the efforts of the plastics pipe industry in the development and standardization of its product has been that of the SPI Thermoplastics Pipe Division through its Executive and Joint Advisory Committees. In connection with their over-all responsibilities, these Committees determine if a proposed standard is necessary and should be developed and, if so, then assign its development to the proper working committee or committees of the Division.

This SPI Division has numerous working committees and committees for liaison with other organizations interested in the development and use of plastic pipe. A brief review of the organization and accomplishments of some of these committees in connection with the development of Commercial Standards and other standards will serve to describe the progress that has been and will continue to be made in the development of plastics pipe to its full potential usage.

There are four active committees and one standing committee concerned with developing dimensional and performance standards on pipe made from as many different types of plastic materials. They are: ABS Pipe and Fittings Committee; Polyethylene Pipe and Fittings Committee; PVC Pipe and Fittings Committee; CAB Pipe and Fittings Committee (recently reactivated); and the Polypropylene Pipe and Fittings Committee (a standing committee).

Other important committees of the Division are: Test Methods Committee with its Working Stress Subcommittee; Fittings Committee; Sewer, Drain and Conduit Coordinating Committee; Nomenclature Committee; Code Committee and its Plastics Pipe Research Council; and Traffic Committee.

Liaison committees consist of the following: American Standards Association B-72 on Plastics Pipe; ASA B-16, Subcommittee XII on Fittings; ASTM-SPI Subcommittee 17 on Plastic Pipe and Fittings of ASTM Committee D-20; American Petroleum Institute-SPI Task Group on Thermoplastic Pipe and Fittings; American Water Works Association Plastic Pipe Standards Committee; and American Gas Association Subcommittee on Plastic Pipe Standards.

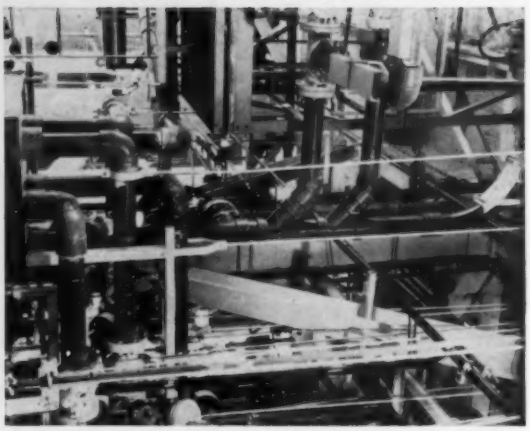
2. Flexible polyethylene pipe water service installation in a suburban home.

Now to show the specific accomplishments of some of these committees in the development of Commercial Standards and other standards and to report on the work being done by joint SPI committees with other organizations:

The ABS Pipe and Fittings Committee through its activities developed and obtained acceptance of CS218-59 on Rigid ABS Plastic Pipe (IPS Dimensions). Standards have been promulgated also on ABS (SWP) and Lightweight (Schedule A) ABS Plastic Pipe entitled CS219-59 and CS220-59, respectively, under the procedures of the U. S. Department of Commerce. These standards have then been used in the preparation of Tentative ASTM Specification D 1527-58T on ABS (IPS) and D 1528-58T ABS (SWP) Plastic Pipe, and the Proposed American Standard on ABS (IPS) Plastic Pipe.

The Polyethylene Pipe and Fittings Committee was instrumental in the development of CS197-61 on Flexible Polyethylene Pipe and earlier editions in 1954, 1957, 1959, and 1960. CS197-61 as well as a Tentative American Standard on Insert Type Fittings for Polyethylene Pipe have now been incorporated in a Use Materials Bulletin of the Federal Housing Administration. CS197-61 is now also being circulated in ASTM format in ASTM Committee D-20 by the ASTM-SPI Joint Subcommittee 17.

PVC Pipe and Fittings Committee activities resulted in establishment of CS207-60 on Rigid Unplasticized Polyvinyl Chloride Pipe, and an earlier edition in 1957. CS207-60 was then introduced into ASTM and has now also been established as ASTM D 1785-60T. Proposed Commercial Standard on Schedule A, PVC (Types I and II) Plastic Pipe has been officially established by the Commerce Department as CS237-61. CS207-60 has



3. Installation of rigid PVC pipe for handling hydrochloric acid and brine in a chemical plant.

been submitted to ASA B-72 Sectional Committee on Plastic Pipe for eventual processing as an American Standard.

Sewer, Drain and Conduit Coordinating Committee obtained the establishment of CS228-61 on Styrene-Rubber Plastic Drain and Sewer Pipe and Fittings, and its 1960 edition earlier. These standards have been published in FHA Use of Materials Bulletin No. 26, and are now also Federal Specifications of the Federal Housing Administration.

The Test Methods Committee was formed to develop and establish reproducible tests on all types of plastic pipe and fittings for such properties which would determine their serviceability. Through its Working Stress Subcommittee under Dr. Frank W. Reinhart of the National Bureau of Standards, a test procedure to determine allowable working stress of plastic pipe has been developed and approved recently by the SPI Pipe Division. A condensed version of the eleventh draft of this "Tentative Method for Estimating Long-Term Strength and Working Stress of Thermoplastic Pipe," has been published.[4] Test data utilizing this tentative method have been requested from members of the ASTM-SPI Joint Subcommittee 17, and others. These data will then be analyzed according to the procedures of the tentative method and may also be used to establish the tentative stress values for writing revised plastic pipe standards. Both pipe producers and ultimate consumers will soon be better able to more properly identify given types and sizes of pipe, know what its working stresses are, and for what fields of application it is best suited, as a result of the work of this subcommittee.

The American Gas Association Subcommittee on Plastic Pipe Standards, consisting of representatives of public utility corporations and plastic pipe manufacturers, was formed in 1952 to consider and evaluate standards on plastic pipe and fittings as they relate to their use in the gas industry. Under the date of May 10, 1956, a report[5] by this subcommittee recommended the use of ABS, CAB, and PVC pipe either in iron pipe or copper tubing sizes, for use in the distribution of natural gas. SPI Pipe Division committees are presently reviewing sections of this report pertaining to their particular pipe materials and will recommend revisions and updating of this report where necessary. The AGA Subcommittee at a meeting on September 19, 1961 recommended Type III polyethylene and ABS Type I, Grade 2 pipe as satisfactory for natural gas distribution. Utility companies are using or considering using plastic pipe in increasing amounts.

The American Water Works Association Subcommittee on Plastic Pipe Standards is considering all Commercial, ASTM and American standards of ASA. It is expected that when ASA pipe standards are established within the next year that AWWA will either accept these standards or prepare AWWA standards on plastic pipe suitable for water service.

The Joint API-SPI Task Group on Thermoplastic Pipe and Fittings was formed to consider plastic pipe for oil country usage. When interim recommended allowable working stress data for plastic pipe become available from the SPI Working Stress Subcommittee, this task group will undertake the preparation of standards on pastics pipe for use by the petroleum industry.

Underwriters Laboratories, Inc. has approved recently certain manufacturers of rigid PVC pipe as sources of supply for this type pipe for use in above ground electrical conduits. Pipe made from other plastic materials are being tested for similar UL approval.

The SPI Pipe Division Code Committee has as it objectives the inclusion of the various types of plastic pipe and fittings in as many municipal, state and national codes as possible, and encouragement of the revision of codes to permit the use of plastic pipe and fittings, wherever suitable. States which presently provide for the use of plastic pipe, either all types or specific types, include Arkansas, Arizona, California, Florida, Illinois, Kentucky, Maine and Wisconsin. The SPI Code Committee is aggressively pursuing its program with code bodies of all 50 states, with a great many further acceptances of plastics pipe and fittings imminent in additional state codes.

Standardization and Refinement of Pipe Sizes

Important problems in improving the quality and acceptance to the greatest possible extent of plastic pipe are those of reducing the variety of overlapping sizes and classes currently being offered and better identifying the limited group ultimately selected for promotion by the industry. Overlapping pipe sizes and classes have been most confusing and frustrating to anyone trying to make an intelligent selection of plastic pipe for either his home or farm or for industrial or utility installations.

The job of weeding out the overlapping sizes and classes is being done by the pipe and fitting committees for the various plastic materials of the SPI Thermoplastics Pipe Division and has been aided by the inability of may of these sizes and classes to meet the specifications of the Commercial Standards and the nSf. The remain-

[4] F. W. Reinhart, SPE Journal, August 1961, p. 751.

[5] "Report of the Subcommittee on Plastic Pipe Standards," John F. Fugazzi, American Gas Association, New York 17, N.Y.

Photo courtesy: Naugatuck Chemical Division, U. S. Rubber Co.
Photo courtesy: Society of the Plastics Industry
Photo courtesy: Colonial Plastics Mfg. Co.
Photo courtesy: Eastman Chemical Products, Inc.

ing sizes and classes are all being subjected to critical scrutiny by each of these committees in a conscientious effort to standardize on the most useful sizes and classes.

The ABS Pipe and Fittings Committee has recommended that the sizes and classes of ABS pipe be reduced to include only 100, 150 and 200 psi-pressure rated systems based on IPS OD's only with appropriate wall thicknesses, these thicknesses to be based on the allowable working stresses recommended by the Working Stress Subcommittee. This recommendation will become effective January 1, 1963.

The Polyethylene Pipe and Fittings Committee has recommended that CS197-61 be revised effective January 1, 1963 also and be limited to Series 1, (approximately 60 pounds, 3 to 6 inch standard Schedule 40 pipe); Series 2, (75 pound, ½ to 2 inch); Series 3, (100 pound, ½ to 2 inch), and revised in accordance with the best technical information and engineering knowledge presently available on the proper design of polyethylene pipe, taking into consideration such items as water hammer, surge, cycling, etc. This recommendation also includes the proper design of fittings and strength characteristics necessary to assure satisfactory results in all installations.

The PVC Pipe and Fittings Committee is proceeding with the development of dimensional and performance standards on 100, 150 and 200 pound PVC pressure rated pipe and fittings with IPS OD's only, and appropriate walls. The effective date for the official establishment of these standards is also January 1, 1963. Pressure ratings higher than those recommended will be included if required for threaded or other specialized PVC piping systems.

Program Coordination—SPI Engineering Manual

All of the above mentioned progress in the development and standardization of plastic pipe, and there is quite a lot more that could not be mentioned in this article for lack of space, is heartening and encouraging. The plastics pipe industry has realized, however, that it would be necessary also to assemble and correlate the results of the work of these various groups into one publication, if possible. The need is for a reference manual outlining the merits and limitations of the different types and sizes of pipe, giving installation procedures, recommended applications, and summarizing the various applicable Commercial Standards as well as providing tables of chemical and physical properties, for use both by the layman and the highly professional technican concerned with specific applications of plastic pipe.

The SPI Thermoplastic Pipe Division has commissioned Martin E. Flentje, chief engineer of the American Water Works Co., therefore, to serve as editor of its Engineering Manual on Plastics Pipe. The contemplated fourteen chapter manual will also cover everything from a brief history of plastics pipe and its development through a description of the extrusion of plastics pipe and into specific chapters on domestic, industrial, agricultural, municipal, oil field and miscellaneous applications. It will include a glossary of terms and will list states, counties and muncipalities who provide for plastics pipe in their plumbing and/or building code regulations.

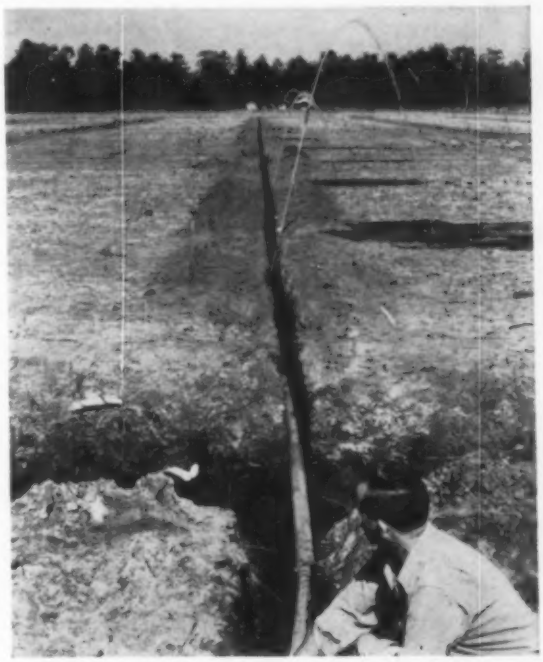
It is expected that the manual will be ready for distribution in the Spring of 1962. The SPI Pipe Division, in a cooperative industry effort, has already made an initial allocation of $50,000 for the distribution of this manual to schools and colleges, trade associations, technical societies, government agencies, public health officials and state sanitary engineers as well as to key distributors and dealers in plastic pipe and through them to the consuming public.

Summary and Conclusions

That all of the above described programs and objectives represent the thinking of the majority of the responsible members of the plastics pipe industry was demonstrated at the Spring and Summer meetings of the SPI Thermoplastics Pipe Division and reconfirmed at the just concluded Fall meeting in New Orleans, La., this month. These meetings were attended by well over 100 men representing producers of better than 90% of the plastic pipe extruded in this country, and by all of the active resin suppliers as well as representatives of the nSf and technical societies and government agencies interested in plastics pipe.

It is hoped that as the buying public becomes better informed of the many advantages of quality plastic pipe made to the requirements of the Commerce Department Commerical Standards, ASTM-SPI, nSf, and other such organizations, that purchases will be made with more emphasis on these specifications than on price and that the high cost of buying plastics pipe not guaranteed by such specifications will become evident. Then the plastics pipe industry will begin to realize its full potential.

—THE END



4. Installation of butyrate pipe at Florida Forest Service Nursery, Olustee, Fla.

F. BARRINER*

Cut costs with disposable mandrels

Reinforced plastic ducting and pressure vessels, especially if filament wound, offer many advantages in the aircraft and chemical processing industries. The making of mandrels for their fabrication had posed many problems in the past, but a family of materials has been developed which offers a real success.—Editor.

Fiber glass-reinforced ducts have gained considerable prominence in the aircraft construction and chemical processing industries during recent years due to several strong features: low weight to high strength ratio; high rigidity at low weight; resistance to impact, bends, or dents which disrupt flow; low heat transfer characteristics; corrosion resistance; and ease of assembly.

Unfortunately, progress toward full realization of these values had been hampered due to the lack of a really satisfactory method of making mandrels for their fabrication. After many years of research and development by the raw material supplier, custom compounder, mold maker, and parts fabricator, a method (and material) has been developed which has every indication of being a definite success.

Most early mandrels were produced from cast, machined, and hand-barbered metals at very high cost. In many cases, these mandrels were actually assemblies of a number of separate pieces. This was necessary in order to permit removal of the mandrel from the cured part.

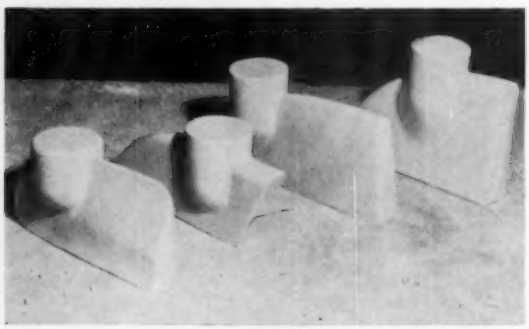


Fig. 1. Cessna mandrel for simple parts afforded a per piece saving of 54¢.

* Cessna Aircraft Co., Wichita, Kan.

Breakaway plasters were the next significant development. The ability to cast or slush mold a one-piece mandrel to the configuration of the duct was, of course, highly advantageous. However, the problem of mandrel removal still remained. It was not uncommon to have a part rejection rate as high as 90%, caused by premature shattering of the mandrel during removal from the mold, during lay-up, or some other time before cure. On the other hand, if the mandrel did not shatter soon enough under repeated impact of the mallet, the part absorbed too much punishment and became a reject.

Due to the relatively low strength characteristics of plaster, it was frequently necessary to cast the mandrel nearly solid so that it would withstand the laminating stress incurred during lay-up and the pressure during cure (vacuum, shrink-tape, etc.). It sometimes required days to chip these nearly solid mandrels out of the part. Although time and labor were far less than in the case of metal mandrels, there remained a 24-hour drying period for the plaster and lack of reliability of the finished mandrel.

Phenolics and other plastics were investigated as breakaway mandrel materials. They had long been used as breakaway props in the motion picture industry but, in their existing form, were found too weak for mandrel application. The problem of combining toughness with brittleness under impact proved nearly insurmountable. There were also handling difficulties associated with catalyzing, pouring, slushing, and curing the phenolic and other resins. These factors, in addition to a relatively high cost, made the effort short-lived.

Finally, a mixture of low-melting, non-metallic compounds—Paraplast** were found to give the proper toughness/brittleness balance. Recognizing that methods and techniques are required which are somewhat un-

** Trademark of Rezolin, Inc., Santa, Monica, Calif.

Table 1. Paraplast Properties by Product Number

	33	36	44	55
Form	Powder	Powder	Powder	Powder
Color	Light red	Light green	Light brown	White
Heat resistance, °F.	275	350	375	475
Coefficient of linear thermal expansion, in/in °F.	4×10^{-5}	3.8×10^{-5}	3.9×10^{-5}	4.1×10^{-5}
Water solubility rate, tap water at 140°F., Min./lb.	5-10	5-10	5-10	5-10
Compressive strength, psi.	17,000	18,000	16,500	19,000
Melting or pouring temperature, °F.	310-330	400-420	410-450	520-550
Pre-heated mold temperature, °F.	150-200	175-225	200-250	300-350
Specific volume, solid cast, cu. in/lb.	13-13.4	13-13.4	13-13.4	13-13.4
Density, solid cast, lbs/cu. ft.	129-133	129-133	129-133	129-133

Fig. 2. Complex part made with Paraplast mandrel at a $3.25 saving per part.

familiar to the breakaway plaster slush molder, the materials were evaluated for almost 3 years by many major aircraft companies and specialty duct manufacturers. As with most new developments, problems arose which necessitated many improvements in the product as well as in the techniques required. For instance, early in the development it was shown advantageous to provide a series of products with different melting points, one to match the cure temperature of each of the thermosetting resins in current use.

Note that each type is color coded according to its temperature range. All four types are not only meltable at relatively low temperatures, but are also water soluble. The product, therefore, could be called a water soluble hot melt.

Paraplasts come ready to use, and require no mixing or weighing. They are simply poured into a smelter and brought to the specific temperature as indicated in Table 1. At this point, the material is poured into the mold and allowed to cool for approximately 3 minutes. A thin shell of material forms adjacent to the mold walls, and

Fig. 3. Mold and set-up for spherical filament winding mandrel.

the excess is poured back into the melter. Molds should be constructed of heat resistant epoxy, metal, or special plastic-faced plaster.

In production, the mold is generally filled from the gate valve. It is advisable to preheat the mold prior to the first cycle of operation. No release agent is required. The finished mandrel is hard, and has a smooth ceramic-like surface. In use, pre-impregnated fiber glass is laid up by hand and cured by either vacuum bag or shrink tape. Mandrel removal is simple—either break out or melt out.

—The End

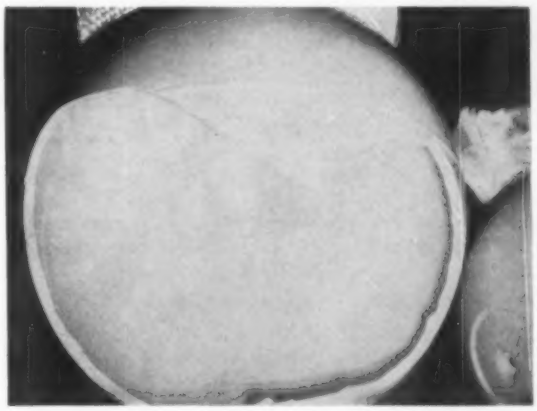


Fig. 4. Cut away section shows the uniform wall thickness attainable with Paraplast mandrels.

Close-up nickel-plated urea element of IBM's Selectric typewriter shows capital letters and characters. The opposite side contains lower case letters, numerals, and other characters.

Urea constitutes unique element in novel typewriter

The key to IBM's new Selectric typewriter is a spherical element which takes the place of the type bars and movable carriage found on present conventional typewriters. The nickel-plated urea printing head, engraved with 88 characters, is produced in a captive operation by IBM's electric typewriter plant in Lexington, Ky.

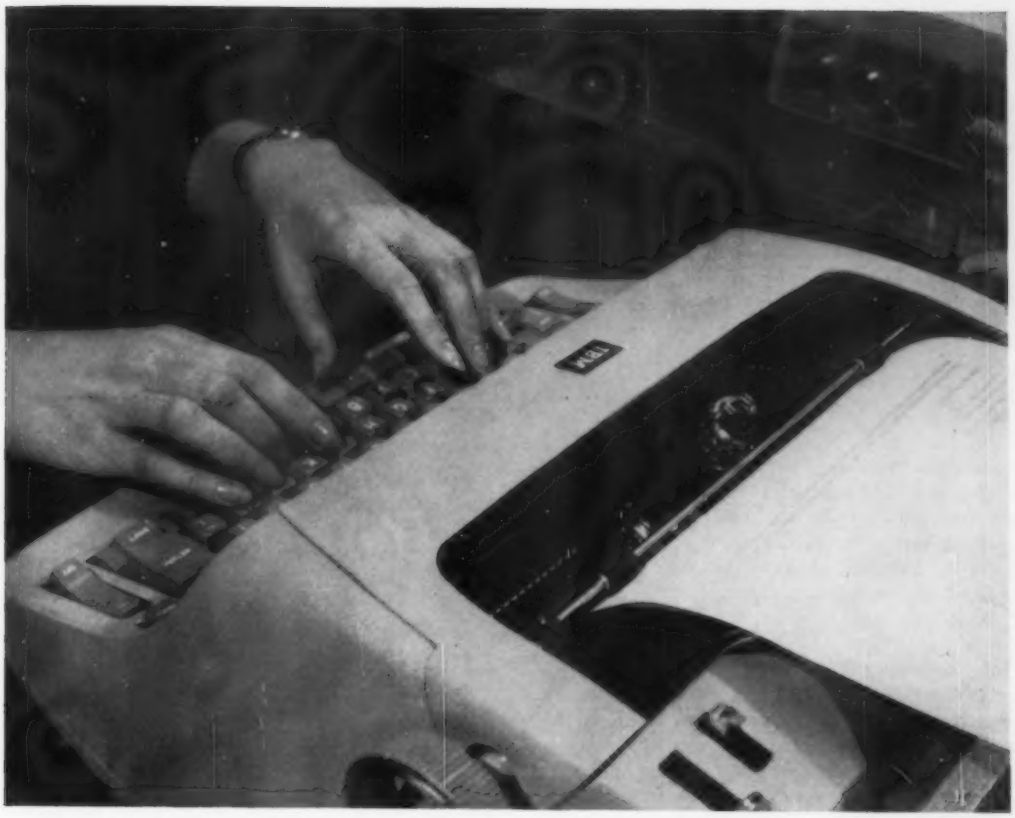
The element eliminates the necessity for type bars and movable carriage because it moves from left to right as it prints. Measuring 1⅜ inches in diameter, the head is mounted on a head-and-rocker assembly which, in turn, is mounted on a carrier. Each half of the truncated sphere contains 44 characters—11 characters in four rows. A touch on the keys activates a system of linkages and pulleys, which tilt and rotate the element in two axes to bring the proper character into position for printing. Immediately, the element rocks forward, leaving its imprint on the ribbon and paper.

Manufacture

In this application, Allied Chemical's Plaskon urea was selected for the carrier. It was chosen because of its impact strength, low shrinkage, and adaptability to molding. Izod impact strength of Plaskon ureas is approximately 0.30 ft.lbs./in. notch; mold shrinkage ranges from 0.006-0.0014 inch; and molding characteristics make it possible to mold large quantities to exceptionally close tolerance.

The red urea powder in the form of pills is molded at 15 tons of pressure and 300° F. for less than a minute. Several refinements take place before the engraved sphere is subjected to plating.

In good practice, the urea sphere is treated with a non-degassing lacquer after molding. Then, unless the molding powder has been made conductive through addition of such materials as carbon or iron filings, the molded product is vacuum metallized with alumi-



The molded printing head eliminates the need for type bars and carriage, as it moves from left to right as it prints.

num, copper, or other conductor. The latter method is preferable, inasmuch as foreign inclusions may influence polymerization adversely. Just before the final plating with nickel, the now conductive urea is treated to an electroplating bath for copper flash.

Other characteristics

Compared with conventional type bar carriages, the Selectric carrier assembly is very light, weighing approximately one pound. The low weight permits fast movements of the carrier when tabulating or when returning the carrier to the left margin.

Rotation of the head is controlled by fine wires running through the machine to the carrier and rocking assembly. When at rest, the element always returns to a position at its upper row and in the center of the 11 characters. Although it may rotate as much as 82° about its axis and approximately 50° about its equator (without depressing the shift key), the head always returns to its basic position. When the shift key is depressed, the sphere rotates 180° to a new position.

The typewriter will print up to 15½ repeated characters per second. Since there are no type bars to tangle, and since the system will store one character while another is being typed, speedy and accurate imprinting is possible. Copy will be neat, with imprints of equal depth, and several types are available. The elements are interchangeable, and by inserting a new one, type face can be adapted to the tenor and purpose of each assignment.

In the history of typewriters, the spherical printing head is actually the third most significant development in type mechanisms. Type bars are the most common. However, in the early days of the typewriter, there was a good deal of discussion as to the relative superiority of the type wheel over type bars. In the former, the types are mounted on a circle or segment, the operation of the keys brings each type to printing position, and a trigger action causes the imprint. This type of operation was never popular commercially, but if the spherical printing head significantly challenges the type bars, it will be a mark in the favor of a versatile plastic.

—The End

PLASTICS TECHNOLOGY
EXPLORING FABRICATION TECHNIQUES

By L. J. ZUKOR, *ENGINEERING EDITOR*

Biaxially oriented polypropylene

What is it that makes one film more desirable as a packaging material than others? A very important factor is price, but machinability, strength, flexibility, visibility, chemical resistance and inertness are also important factors. Non-toxicity, printability, gloss and texture may also influence the choice of material.

Let us, for example, consider polypropylene, which offers many advantages as a film-forming resin. Compared to polyethylene, however, it has less impact resistance at low temperatures unless biaxially oriented.

In the November, 1960 and January, 1961 columns, I pointed out that when a film is oriented, its tensile and impact strengths and tensile modulus are increased. "Balanced*" biaxially oriented polypropylene film has properties approaching those of oriented polyester films. In addition, polypropylene has the lowest density of all film forming resins and excellent resistance to environmental stress cracking. Presumably, biaxially oriented polypropylene film should take over a large share of the packaging market. Despite the research being done both here and abroad on film orientation, however, no manufacture or investigator has yet established a satisfactory production method for producing a balanced, oriented polypropylene film.

Mr. J. Jack, BX Plastics Ltd., of Great Britain, in a recent article,** intimates that the most efficient means of obtaining a thin, balanced, biaxially oriented film would be the blown film method, using a fast quench followed by annealing. Some American firms are presently evaluating this method. Pilot amounts of this film have been exhibited and tried in various packaging applications with some success. Current production, however, is being made on stentering equipment (See Jan., 1961, page 60).

Also in this column in January, I indicated two other methods which have been used successfully to make a balanced, oriented film. One passes the film through a series of pressure rolls. This method lends itself preferably to the production of films which remain in an amorphous state while being worked, but can be modified to work those materials which tend to form crystal aggregates at elevated or melt temperatures. Isotactic polypropylene is such a material. Two passes through the rolls are necessary to orient the film biaxially, but, the operation is continuous and biaxially oriented film is obtained at the wind-up end.

Polaroid Corp., Cambridge, Mass. has designed a machine to orient plastic films which stretches material between two opposing traveling belt surfaces that are under pressure, thus maintaining a "holding" force on the sheet surface. The sheet then passes through the nip of a set of draw rolls which pull it from between the belts at a predetermined speed and angle. The relationship of the surface speed and angle of the draw rolls to the belts determines the amount of stretch and angle of orientation. Heat is introduced as film leaves the draw rolls to facilitate stretching. Uniformity of stretch and orientation is assured by "setting" the material while it is still under tension.

The other method, still a heavily guarded secret, uses ultrasonic vibrations as the work force. I have seen samples of film oriented by this method which exhibit excellent gloss and clarity.

Manufacture of a good film starts with extrusion. Sheet extrusion for polypropylene is more critical than for other thermoplastic materials. Since the recom-

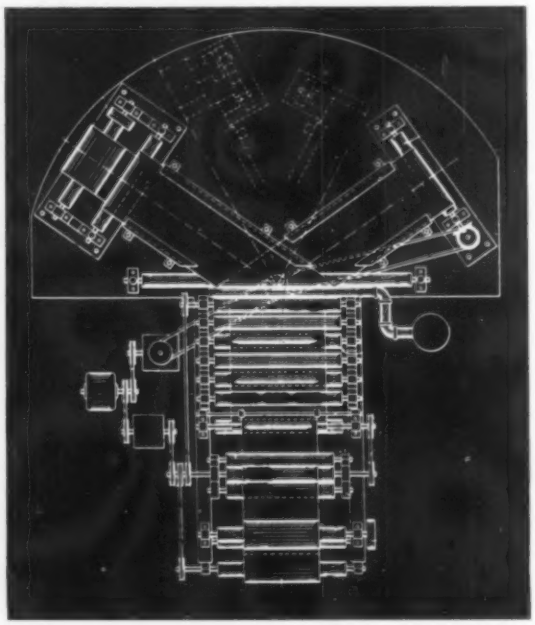


Diagram courtesy: Polaroid Corp.

Rolling unit plan view diagram.

*When tensile strength in both the machine and transverse directions are approximately equal, the film is known as "balanced film."

** Biaxial Stretching of Polypropylene," by J. Jack, BRITISH PLASTICS, June-July, 1961.

mended temperatures for polypropylene film extrusion are as high as the material will withstand without degrading, a long-barrel extruder with a L/D ratio of 20:1 to 24:1 is recommended to minimize localized overheating and to allow the temperature to be raised uniformly. A metering screw with constant pitch, such as that used for nylon, will work extremely well with polypropylene, although a 4:1 compression ratio screw as used for polyethylene is also satisfactory. Polypropylene film grade formulations differ in the amounts and types of stabilizer they contain and in the amount of atactic or amorphous polypropylene contained in the isotactic or crystalline polymer. While all of these formulations will mix well with each other, a large number of spherulites could form at nucleated sites due to the introduction of foreign matter and thus reduce clarity. Spherulite formation is zero above its melt temperature and theoretically zero when polypropylene film is instantly chilled to a solid. Between these temperature extremes, spherulite formation and crystallization growth rate reach a maximum.

It is necessary to know the optimum temperature conditions which will make the best film for each particular formulation. For example, Hercules #6420 film grade resin is stabilized, has FDA approval, and its melt temperature is 330°F. Extrusion temperatures recommended for this polypropylene are 400°F. just forward of the hopper opening, and 500°F. at the throat and die sections. Eastman Chemical Products, Inc. recommends optimum conditions for its #4240 in its technical report #9. Other resin producers, such as, AviSun, Enjay, and Montecatini each recommend optimum conditions for their resins.

Clarity is improved with increased stock temperature and quick chilling. Freezing the film at a low order of crystallinity also improves its impact strength. This holds true whether the film is made by blowing or chill roll-casting, or when film is further worked in stentering or rolling operations.

Many seem convinced that the blown film method will become the production method for preparing "balanced" biaxially oriented film. Others contend that higher production is possible by the chill roll method and that by rolling one obtains a balanced oriented film with the least loss of clarity. They feel that while

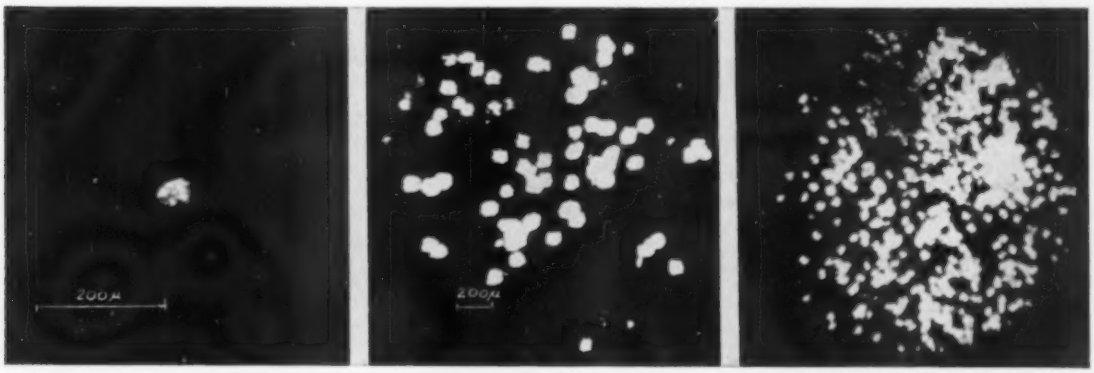
Photo courtesy: Polaroid Corp.

Rolling unit for orienting continuous sheet materials.

it is possible to chill blown film (initial parison) quickly, reheating to be able to form a film without tearing requires a relatively long period to recool the bubble, which produces a slight haze in the film. It is also well known (from polyethylene and Saran production figures) that the chill roll-casting method provides higher production.

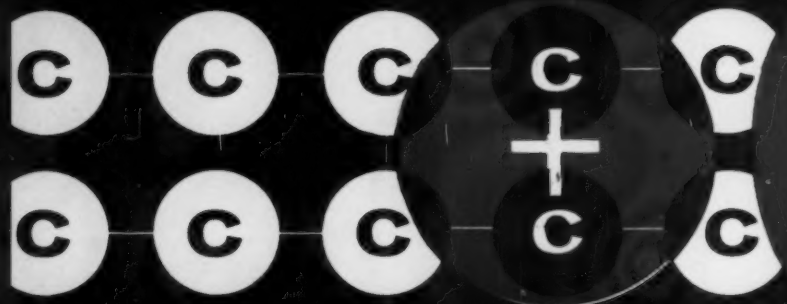
Stentering can be done with or without heat setting, a stress relieving or annealing operation which reduces the shrink characteristic of oriented film. In machines equipped with hot air enclosures, the film is reheated to 265-275°F. for a minimum of five seconds while the film is still restrained. Biaxially oriented film is made by reheating M.D. prestretched material to approximately 300°F. in the first heat zone and stretching the film in the transverse direction (T. D.) as it enters the second heat zone. Temperature of the second zone should not be less than 250°F. to prevent necking and tear. Exact temperatures depend on the resin formulation and machine speed. One advantage this method has over that of rolling is that film can be oriented in the machine direction as it is cast. It is, however, extremely difficult to rework polypropylene in the transverse direction and still obtain a clear, balanced film. Many agree that a slight imbalance is still satisfactory for most applications.

—THE END



Photos courtesy: Olin Mathieson Chem. Corp.

Photomicrographs of spherulite growth; (left) 1.75 Hr. at 293° F., (center) 42.5 min. at 278.6° F., (right) 91 sec at 258.8° F. Diameters increased as a linear function of time.



DI-CUP... *Key Link in Cross-Linking Polyethylene*

Di-cup, Hercules dicumyl peroxide, is a source of free radicals, which are highly effective in chemical cross-linking. It provides a simple, economical, and practical means of cross-linking low-density polyethylene.

Cross-linked polyethylene is a thermoset material resistant to softening and deformation at high temperatures. It shows no evidence of environmental stress cracking and it is resistant to many solvents at high temperatures.

This development opens new markets for products that require superior toughness, flexibility, impact strength, and chemical resistance.

For more information on Di-cup, write

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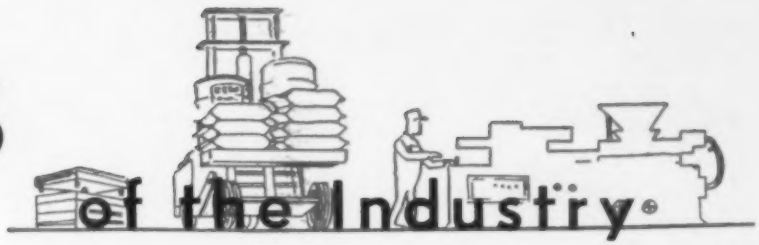
NEWS of the Industry



changes in ownership

Atlantic Refining Co. has acquired a majority interest in J. P. Frank Chemical and Plastic Corp. J. P. Frank will continue as director and consultant, and H. Hilsenroth and M. Frank, also officers of the firm, will continue in the active management as vice presidents and directors.

Burton Mfg. Co., Northbridge, Calif., has acquired Technical Plastics, Inc., of San Mateo, which it will operate as a division.

Cabot Corp. has acquired the business and manufacturing facilities of Acheson Industries, Inc., Port Huron, Mich. The latter will retain operations of its colloids subsidiaries, but Cabot will operate the plants in Philadelphia, Orange, Tex., and Xenia, O., as the Acheson Dispersed Pigments division of Cabot Corp.

Cosden Petroleum Corp. has formed a subsidiary, Cosden Petrochemical Corp., with offices at 235 East 42nd St., New York City. Franklin Eck heads the firm as president.

Decorative Engineering & Supply, Inc., has acquired Production Spray Mask of Mar Vista, Calif. Operations have been consolidated at 17000 S. Western Ave., Gardena.

Deluxe Tool Corp., North Bergen, N. J., plans to change its corporate name to Luxite Saw & Tool Corp. The firm manufactures a line of carbide tipped saw blades, cutters, router bits, and knives for use in the plastics industry.

Moore Mfg. Inc., San Francisco, has purchased Aetna Mfg. Co., Inc., which becomes its AMCO division. Headquarters will be in San Francisco, and the plant will be in Burlingame.

Polyply, Inc., Amsterdam, N. Y., has purchased the reinforced plastics division of Fiber Glass Industries, Inc. Roger B. Knowles, president of Polyply, was a co-founder of Fiber Glass Industries.

Pratt, Read & Co., Inc., Ivoryton, Conn., has acquired Tech-Art Plastics Co., Morristown, N. J. The latter firm's former board chairman, J. H. DuBois will be vice president of the new firm.

Reichhold Chemicals, Inc., has signed an agreement with Simpson & Co., Ltd., for the formation of Reichhold Chemicals India Private, Ltd. Facilities will be located in Madras, India.

new plants, labs & additions

Allied Chemical Corp. has begun construction of a phthalic anhydride plant next to its existing plant in El Segundo, Calif.

Circle Machine Co., Inc., Haverhill, Mass., has inaugurated a consultancy service to manufacturers and users of electroformed slush molds.

Glidden Co. has approved expenditure of over $1-million for expansion and modernization of four of the company's coatings and resins plants. Facilities earmarked for improvements are in Atlanta, Chicago, Toronto, and St. Louis.

Guild Plastics, Inc., a division of Maryland Cup Corp., is constructing a new plant in Wilmington, Mass., for the manufacture of disposable plastic containers. The entire operation will be moved from Cambridge to the new site. The 110,000 square foot plant will house about 200 employes.

Hobbs Mfg. Co. is building a 42,000 square foot plant in Worcester, Mass.

Owens-Illinois Glass Co. has opened the first of its two blown-plastic bottle plants in the South. Locations are Charlotte, N. C., and Atlanta.

Thatcher Glass Mfg. Co. has completed its 1,400-mile move from Nashua, N. H., to Muscatine, Ia. The move should triple production of vinyl, polyethylene, and polypropylene squeeze tubes.

news from abroad

American Cyanamid Co. is constructing a methylmethacrylate facility at its plant in Wallingford, Conn. Completion is scheduled for mid-1962. Molding powder will be produced under a license obtained earlier this year from Imperial Chemical Industries, Ltd., of Great Britain.

Ciba Products Corp. has been named exclusive sales agent for Eporal, an epoxy curing agent for applications requiring a long shelf life. Eporal is a product of Roussel Corp. of New York.

Germany. A blow molding machine in which two die-blocks operate in hand-over-hand fashion to produce a continuous chain of hollow products was shown at the Hanover Fair.

Japan. A new polyketone resin has been synthesized from ethylene and carbon monoxide with the aid of gamma rays. Inventor is Professor Murakoshi of Osaka University.

←For more information check Readers' Service Card No. 124

Names in the News

R. C. Hyatt

Robert C. Hyatt is director of marketing, Antara Chemicals division, General Aniline & Film Corp. Previously director of marketing in the Collway Pigments division, he succeeds **James M. Cloney,** now general manager of the Ozalid division.

Hugh B. Allison and **Joseph S. Hawes** have been elected to the board of directors of Chemical Products Corp. Both have been serving as sales vice presidents since 1957.

Hugh G. Johnson, director of Johnson Rubber Co., retired June 12 from the post he had held for 63 years. He is the founder of the Middlefield, O., company.

Robert Shevett has moved up from the position of sales manager to vice president in charge of sales, Rainville Co., Inc. He has been employed there for six years.

Chester J. Schmidt

Chester J. Schmidt has retired as vice president and general manager of J. O. Ross Engineering division, Midland-Ross Corp. Mr. Schmidt, who will continue to serve the company as a consultant, joined Ross in a managerial post in 1930. His responsibilities for general management have been temporarily assumed by **Robert J. Jacobs,** vice president and general manager of Waldron-Hartig division.

Robert Slater, vice president-sales for Marco Co. and Panel Structures, Inc., has resigned to become vice president and general manager of Pacific Sealants. In his new post, Mr. Slater plans an expanded distribution of the firm's products, as well as development of new architectural and engineering products for marketing to construction industries.

Harry Mandel is now president of Beaman Plastics, Inc., Portland, Ore. He formerly owned and operated Aeroplant Luggage Corp., and for the past seven years was production manager of Multnomah Trunk & Bag Co.

John B. Mackenzie, Jr., has been appointed marketing coordinator-plastics by Enjay Chemical Co. He replaces **Carl Virgin,** who will coordinate the introduction and marketing of new plastic products and their applications. Mr. Mackenzie joined Enjay in April after serving as marketing manager for Haveg Corp.

Thomas E. Brydon has been named product manager—polystyrene by W. R. Grace & Co., polymer chemicals division. Mr. Brydon joined Grace in 1959 after four years with Dow Chemical Co.

Frank B. Knight

Frank B. Knight has been named vice president, and **G. Edward Ammerman,** general sales manager, at Chromalox, Inc. Mr. Knight joined Chromalox as general manager three years ago, after serving as manager at Clark division, McGraw Edison Corp. Mr. Ammerman has been with the company for seven years as manager of the appliance products division.

Two men have been named to managerial posts at General Electric's silicone products department. **William C. Giegold** has been appointed manager of quality control, and **Frank V. Summers** has succeeded him as manager of intermediate process engineering. Mr. Summers was employed as a process economics engineer at the time of his appointment.

Howard T. Cusic has been elected president and chief executive officer of U. S. Polymeric Chemicals, Inc. He succeeds **Maarten W. Oudegeest,** who has been elected chairman of the Board. Mr. Cusic was formerly vice president and general manager of the company's eastern division.

Aimison Jonnard has been named manager of market research and development

Dr. Aimison Jonnard

for U. S. Industrial Chemicals Co. Dr. Jonnard, who joined U.S.I. in 1959 as assistant manager, polymer planning and applications, will be responsible for markets for both present and future products.

Stuart H. Jacobs has been appointed secretary-treasurer of Barnett J. Danson & Associates, Ltd., Toronto, and **Lothar Bohlmann** has joined the company as technical service manager.

DeBell & Richardson, Inc., has announced the appointments of several specialists to its plastics research and development laboratory staff. **Herbert A. Ehrenfreund** has been designated project engineer specializing in packaging development with emphasis on the economics of foamed materials and processes; **J. Robert Fisher**—senior project engineer, project development; **Dr. Dudley M. Gallagher**—senior chemist specializing in organic synthesis and polyester fibers; **B. J. Skowronski**—senior chemist specializing in elastomer compounding; and **Henry C. Winiarski**—senior chemist, compounding.

William S. Powell has been elected president and chief executive officer at Hexcel Products, Inc. He was previously senior vice president in charge of manufacturing subsidiaries for Consolidated Freightways, Inc. **Roger C. Steele,** president and founder, becomes chairman.

George J. Muller

George J. Muller, formerly manager of technical service, Taylor Fibre Co., has been named manager of the special projects group. Assisted by project engineers **Francis M. Guiney** and **Horace E. Scherer,** he is responsible for inquiries or orders requiring complicated engineering, new material, new manufacturing techniques, or sophisticated tooling.

Names in the News (Cont'd.)

Richard J. Kerr has been moved up from product manager—urethane intermediates at Union Carbide Chemicals Co. Now, as product manager—epoxies and plasticizers, he will be responsible for market development of these products and others derived from peracetic acid or related to reinforced plastics.

Donald E. Hudgin has been appointed associate director of research for polymers in Diamond Alkali Co.'s research department. Dr. Hudgin has been associated with several major chemical companies during the past 14 years.

Wm. W. Boeschenstein

William W. Boeschenstein, vice president of Owens-Corning Fiberglas, has been named head of the corporation's sales branch operations. For the past two years he has been located in Detroit as central region sales manager.

John T. Whitely and **H. Nelson Flanders, Jr.**, have been elected secretary-treasurer and controller of Amerace Corp. Mr. Whitely was formerly an executive vice president of W. R. Grace & Co. Mr. Flanders had been Amerace's secretary-treasurer.

Robert S. Temple

Robert S. Temple is the first sales manager for plastics of Valchem. Formerly associated with Union Carbide, Allied Chemical, and Naugatuck Chemical division, U. S. Rubber Co., he will be responsible initially for polyester resin sales.

Simon Collier and **William A. Zinzow** are among the five men who have been named to honorary membership in ASTM. Mr. Collier, a quality control consultant in New Rochelle, N. Y. and retired director of quality control, Johns-Manville Corp., was commended for his contributions in technical and administrative activities, especially in the areas of rubber and rubber-like materials and quality control. Mr. Zinzow, retired assistant director of development, Bakelite Co., received recognition for leadership in and contributions to the fields of plastics, rubber, and electrical insulating materials.

Zenas Crocker

Zenas Crocker has been elected executive vice president of Nixon-Baldwin Chemicals, Inc. Mr. Crocker had been a vice president since the company was formed and acquired Nixon Nitration Works last year.

Two executive appointments have been announced in the western region of Cabot, Corp. **R. E. Dobbin,** formerly director of research and development, has been made general superintendent for carbon black manufacturing in the carbon black division. Mr. Dobbin has held several positions in research and development since joining Cabot in 1940. **N. Dudley Steele,** most recently in the region's production department, has succeeded him.

Emil A. Wich

Emil A. Wich has been named manager-technical service and development at Collway Pigments division, General Aniline & Film Corp. He has been with the corporation for 25 years, most recently as manager-technical service.

John T. Castles has been appointed general manager of the chemical materials department of General Electric Co. Formerly manager of the division's chemical development operation in Bridgeport, Conn., he succeeds **Dr. A. Eugene Schubert,** now manager of the power transformer department.

Recent appointments at the polymer and plastics development laboratory of Celanese Polymer Co., Clark, N. J., include **Michael J. Curry** as laboratory director and **Peter R. Lantos** as manager of the product application department. Dr. Curry was formerly manager of plastics research at the Summit, N. J., laboratories of Celanese, while Dr. Lantos was with Du Pont.

For more information check Readers' Service Card No. 125

New Materials

For more information check Readers' Service Card (p. 79)

Epoxy resin for filament winding

Bakelite ERL-0500 is a specially developed low viscosity epoxy resin for use in the filament winding process. Bakelite epoxy ERL-0500 is trifunctional, has a built-in tertiary amine catalyst, a viscosity of 2000-4000 cps. at room temperature, and is available from the Union Carbide Plastics Co.

In filament wound structures required for elevated temperature applications such as missiles and rockets, an ERL-0500 based system is particularly effective since, in addition to low viscosity, it has long pot life and readily combines with the commonly used liquid anhydrides. High cure temperatures have no detrimental effect on ERL-0500 filament wound structures, but do increase the heat distortion point considerably. Girth stresses approaching 120,000 psi. and interlaminate shear values of 4000 psi. have been developed with an ERL-0500 methyl nadic anhydride system, which has an initial viscosity of 550 cps. at room temperature.

The low viscosity and long pot life of ERL-0500 based systems permit the winding of complicated glass patterns with no practical limit on winding time or on the complexity of the pattern laid down, and insure good wet-out of filaments and uniform resins flow.

Readers' Service Item 1

Impregnating solutions

QO Fapreg is a stable, low viscosity impregnating solution based on furfuryl alcohol ideally suited for penetrating and filling voids in porous materials such electrodes, etc. It is available from the Quaker Oats Co., Chemicals Div., in grades P-3 and P-5. Both convert into infusible and chemically inert dark-colored resins. Porous carbon treated with Fapreg is chemically resistant, strong, and dense as well as impermeable to air and corrosive liquids.

Fapreg P-3, recommended for processes which use pressures of 80-100 psi. in the curing step, contains 3% QO Activator and is ready for use as received. Refrigeration is not required during storage of drum quantities; when stored outdoors for one year viscosity increased only from 5 to 20 cps.

Fapreg P-5 impregnated items will be cured at atmospheric pressure by adding 2% QO Activator at the time of use; hence, the Activator is shipped separately and dissolved by the user. Extended stirring is necessary. Fapreg P-5 is not as stable as P-3, but the former will remain in the viscosity range of 5 to 25 cps. for several months at about 75° F.

The use of Fapreg for the impregnation of paper and other fibrous webs is not generally recommended.

Readers' Service Item 2

Lead stabilizer has plate-out resistance

"NoPlate" Lead Stabilizer, Code Q-11266, is a more efficient replacement for "NoPlate" Lead Stabilizer, Code D-11074, of the Claremont Pigment Dispersion Corp., for vinyl film and sheeting. Calendered vinyl materials formulated with Code Q-11266, as the sole lubricant and stabilizer, are bright and lustrous because of the absence of metallic streaks which usually mar and dull the plastic surface.

Plate-out is eliminated by using Code Q-11266 in conjunction with Claremont's "Qwikmil" Silver, Code Q-7802. Code Q-11266 will not eliminate plate-out when used with other commercially available aluminum pigments. To achieve complete plate-out resistance and maximum compound stability, 8.3 parts of Q-11266 is used per 100 parts of resin. Absolutely no stearates, stearic acid, barium or cadmium stabilizers or aluminum pigments, other than "Qwikmil" "NoPlate" Silvers should be added to the compound, since they will destroy the plate-out resistance contributed by Code Q-11266.

A corresponding non-lead stabilizer will be available shortly.

Readers' Service Item 3

Adhesives and sealants for high temperatures

Raiseal 100, 200, and 300 adhesives and sealing compounds containing a finely divided metallic filler and Raiseal 250 and 350 formulations containing a fine mica filler have been developed by Radiation Applications Inc. The Raiseal 250 and 350 series have been specially formulated for the electronics industry for applications requiring extremely high thermal and electrical resistance in addition to the temperature resistance and mechanical strength of the 200 and 300 materials. The latter adhesives have better heat transfer properties than 250 and 350; other properties are roughly the same.

Raiseal 100 is a two part compound based on RTV silicone rubber; Part A is the main compound; Part B is the catalyst Raiseal 100-1 is a special primer for use with RTV silicones. Raiseal 100-A requires 1% by weight of 100-B. Bonded specimens should be cured at room temperature for 48 hours followed by a cure of 16-20 hours at 480°F. Lap shear tests show a strength well in excess of 300 psi for bonded metal surfaces as measured at 700°F. after a one hour soak at 700°F. at 60 psi.

Raiseal 200 is a one part putty-like compound for sealing and encapsulation at temperatures in excess of 800°F. Slight modifications in viscosity can be made with xylene as a solvent. Bonded assemblies are cured one hour at 150°F. Followed by two hours at 300°F. For maximum thermal stability, a post cure of 16 hours at 500°F. is recommended.

Raiseal 300 is a two part, high temperature adhesive with functioning potential up to 1000°F. Raiseal 300-B (the catalyst) is mixed 1.5 parts with 100 parts of 300-A; after application to the surfaces to be bonded they are allowed to stand one-half hour at room temperature or heated for five minutes in an oven at 120-130°F. The assembly is cured one hour at 150°F followed by two hours at 300°F., and then post cured 16 hours at 500°F. for maximum thermal stability. Raiseal 300 has greater impact resistance and flexibility than phenolic or epoxy adhesives and is far less brittle than comparable high temperature ceramic adhesives. A lap shear test with aluminum gave an average ultimate strength of 600 psi after one hour at 1000°F.

Dip impregnation of asbestos forms in thinned Raiseal 350 increases their electrical resistance and improves their bondability to metal surfaces. The asbestos pores are then made impervious by joining the two surfaces with uncut Raiseal 350 which acts both as a bonding agent and a sealant. Raiseal pretreated asbestos forms are finding industrial use in the encapsulation of potted electrical components where the forms act to insulate the potted component both thermally and electrically. Raiseal 350 has been found to be very effective as a structural adhesive for service at temperatures of 1000°F.

The usual cleaning of metal surfaces to free them from oil and grease, etc., are recommended with all of these adhesives.

Readers' Service Item 4

Two adipate plasticizers

Two new adipate plasticizers, Monoplex DIOA (di-iso-octyl adipate) and Monoplex DDA (di-iso-decyl adipate), which provide efficient, low-cost plasticizing action, excellent low temperature flexibility and permanence properties adequate for many purposes in polyvinyl chloride, are available from Rohm & Haas.

Monoplex DIOA is an efficient primary plasticizer for vinyl chloride polymers, nitrocellulose, ethyl cellulose, and many synthetic rubber types. As a plasticizer for various PVC resins, it provides good processing characteristics for calendering, extruding, and dispersion compounding. A chemically stable ester, Monoplex DIOA, provides compounds with good heat and ultraviolet light stability. In plastisols and organosols, its low initial viscosity and low solvency for dispersion grade vinyl resins results in dispersions with good handling and storage characteristics.

Monoplex DDA is a low temperature plasticizer for PVC polymers and copolymers, ethyl cellulose, nitrocellulose, and polystyrene. Although not classified as a primary plasticizer, it can be used in substantial quantities to take advantage of

its excellent cold resistance. Monoplex DDA is similar to octyl adipates in its ability to improve calendering and extruding characteristics, but also exhibits greater resistance to volatile loss and soapy water extraction. In plastisols, it contributes very low initial viscosity and good shelf life.

Some typical properties of these two adipate plasticizers are given below:

	DIOA	DDA
Specific gravity, 60° F./60° F.	0.924	0.915
Refractive index	1.447	1.451
Color, APHA	20	20
Viscosity, 25° C., poises	0.134	0.212
Freezing point, °C.	< −70	—
Gel point, °C.	—	−70
Flash point, °F.	400	430
Fire point, °F.	440	470

Readers' Service Item 5

Glass reinforced polyesters for molding electrical parts

Two new fiber glass reinforced polyester compounds for molding electrical parts have been developed by the Glastic Corp.; Grade 1706 with high dielectric plus high impact strength, and Grade 1504, a flame retardant compound with medium impact strength.

Parts produced with 1706 have a dielectric strength of more than 400 volts per mil, Izod impact strengths of 6 ft. lbs./in., excellent thermal stability, and high resistance to arcing. Coil shells and forms are typical applications of this compound.

Parts made with 1504 have Underwriters Laboratories-recognized flame retardance and Izod impact strengths of 3 ft. lbs./in. This compound has excellent modability in deep draw parts. Typical applications of 1504 are circuit breaker housings and standoff insulators.

Some typical physical, electrical and molding properties of these two compounds follow:

	1706	1504
Colors	Tan	Gray, black
Specific gravity, molded	1.85	2.2
Bulk factor	1.5	Approx. 1
Form of material	Fibrous	Extruded
Shrinkage, compression molded	0.002–0.004	0.001–0.004
Molding temperature, °F.	240–300	240–300
Cure time, 1/16 in. section, sec.	60	60
Flexural strength, psi.	20,000	10,000
Compressive strength, psi	17,000	15,000
Tensile strength, psi.	6,000	4,000
Water absorption, 24 hrs./23° C./%	0.2	0.5
Heat distortion temp., 264 psi, °F.	>400	—
Flammability, sec. ign./sec. burn	—	90/80
Arc resistance, sec.	130	130
Dielectric strength, S.T., perp., v/mil	400	300
Dissipation factor, 60 cycles	—	0.04

Readers' Service Item 6

Ester type plasticizer

RC Plasticizer TM, a tri-ester of trimellitic anhydride with a molecular weight of 548, is a new development in ester-type plasticizers by the Rubber Corporation of America. A material is now available which combines the best features of both monomeric and polymeric plasticizers for compounding vinyl plastics. The relatively high molecular weight of this primary plasticizer assures low volatility while its ester groups result in excellent solvation and compatibility. Electrical characteristics are excellent and Plasticizer TM is recommended for all quality uses requiring a high degree of permanence together with ease of processing.

Plasticizer TM in PVC at 50 phr has an SPI volatility (24 hrs. at 70°C.) of 0.35%; soapy water extraction (24 hrs. at 50°C.) of 0.01%; and mineral oil extraction (24 hrs. at 50°C.) of 3.2%. Some other properties of the plasticizer are as follows:

Appearance	Clear liquid
Color, APHA	200, max.
Odor	Mild
Specific gravity, 20°/20° C.	0.992 ± 0.002
Acidity, as acetic	0.02%, max.
Moisture	0.05%, max.
Viscosity, 23° C., cps.	262
Flash point, c.o.c., °F.	500
Freeze point, °C.	Gel at −45
Mid-boiling point, 2.5 mm. Hg., °C.	283
Refractive index, 23° C.	1.482
Saponification No.	305
Solubility in water, 23° C.	0.03%
Water solubility in TM, 23° C.	0.01%

Readers' Service Item 7

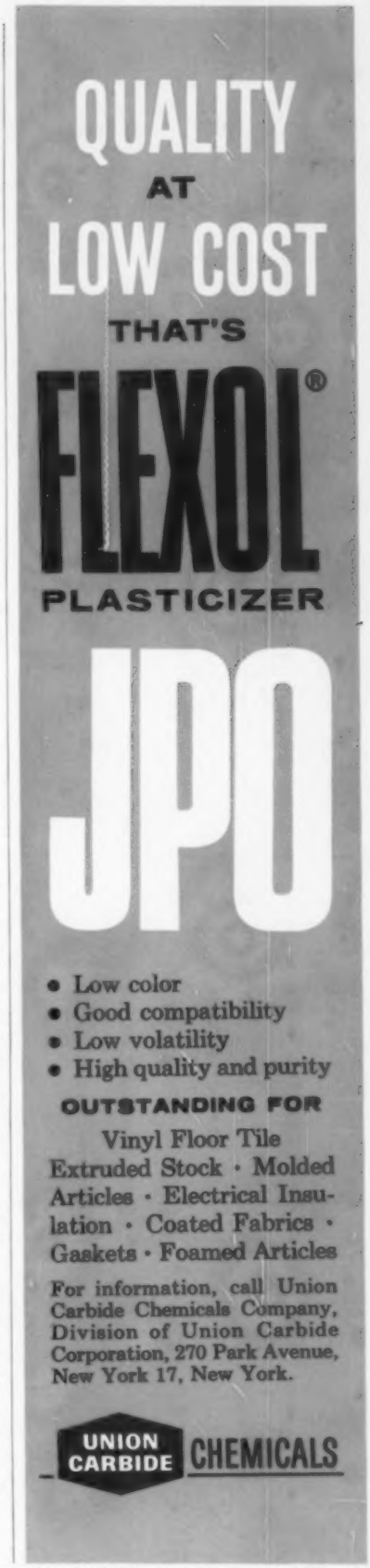
Room temperature epoxy adhesive for high temperatures

Epoxylite #810, a new, two-component, room temperature curing epoxy adhesive with improved service characteristics at 400°F., has been announced by the Epoxylite Corp. Consisting of an epoxy paste and a powdered curing agent, this new epoxy adhesive not only provides excellent adhesive strength at 400°F. but also withstands thermal softening and maintains good adhesive strength for well over 100 hours at this temperature. It is said to be the first room temperature curing epoxy adhesive to have the ability to withstand thermal softening at temperatures as high as 400°F.

Epoxylite #810 has a pot life of 15 minutes at room temperature; it cures in thin glue lines in 24 hours although several days are required for the development of maximum adhesive strength. Heat may be used to speed cure but in general large bake ovens are not needed in many production situations. Maintenance operations requiring material with high strength at elevated temperatures may now be performed in the field.

Preliminary field uses have involved bonding of reinforcing hat-cap sections to high speed aircraft panels, patching ablation shielding on missiles, and bonding lead balancing weights on high temperature electric armatures.

Readers' Service Item 8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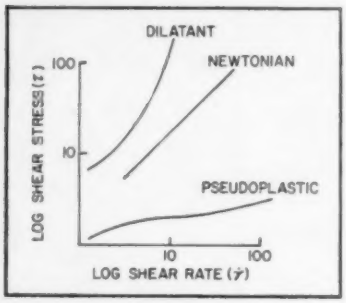
$$\eta = \frac{\tau}{\dot{\gamma}}$$

NEWTON AND THE NON-CONFORMIST FLUIDS

Newton's classical hypothesis, stated above, provides a basis for the study of viscous flow. However, many viscous fluids behave in a non-Newtonian manner. In polymer melts, for example, viscosity may vary with pressure and flow rate. These properties must be measured — with accuracy — in order that their behavior may be predicted in advance. Knowledge of flow behavior assists the researcher in studying molecular structure . . . helps the engineer in designing more efficient process equipment. Which is why we're using this space to tell you about the new Instron Capillary Rheometer, a valuable and versatile new tool for studying the behavior of polymer melts and other non-Newtonian fluids.



Newtonian fluids have constant viscosities with shear stress proportional to shear rate. Dilatant fluids show an increase in viscosity while pseudoplastics become more fluid at higher flow rates.

Designed for use in INSTRON Tester

The new Instron Capillary Rheometer (Type MCR) consists of an extrusion assembly mounted on an Instron Universal Tester. Temperature controls are contained in a separate cabinet. A sample of polymer or other non-Newtonian fluid is forced out through a capillary by a plunger driven by the moving crosshead of the INSTRON.

This basically uncomplicated arrangement makes possible a new level of convenience, accuracy, and versatility in the study of non-Newtonian fluids. For example:

Constant shear rate — The selected speed of the servo-controlled INSTRON crosshead is constant and independent of load; therefore, extrusion speeds and shear rates are constant. *Wide range of speeds* — The plunger is driven at speeds covering the range of 1000:1 in precise steps. *Permanent record* — Plunger force at each speed is detected by a load cell and plotted on the recorder. The force curve often indicates special flow properties such as critical shear rate. *Interchangeable capillaries* — For studying the effects of entrance, exit and transient losses. *High precision heat control* — a wide range of temperatures controlled to ±0.5°C.

Capillary Rheometer Mounted On Floor Model Instron

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INSTRON

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For more information check Readers' Service Card No. 127

New Alkyd Molding Compounds

Two new electronic grade alkyd molding compounds, Plaskon alkyd (DAP) 541 and Plaskon alkyd 428, have been announced by the Plastics Division, Allied Chemical Corp. Plaskon 541 is an impact type thermosetting molding material combining glass fiber reinforcement with a diallyl phthalate resin and is furnished in a special macerated form to reduce bulk factor and facilitate handling prior to molding. Plaskon 428 is a glass fiber reinforced granular compound and very fast curing. It combines the desirable mechanical and electrical properties of glass fibers with the handling ease of a granular material.

Plaskon 541 is manufactured with diallyl phthalate resin to meet requirements of MIL-M-19833 (SHIPS), Amendment 3 for a Type GDI-30F compound, and is classified as "flame retardant." Parts molded from 541 have a well balanced combination of electrical properties, high mechanical strength, and dimensional stability, and retain these values after prolonged exposure to high humidity at elevated temperatures. The material molds well in heavy sections without internal cracks and voids and its extended flow aids insert retention and reproduction of intricate shapes. It will not corrode electrical contacts.

Plaskon 428 molded parts show very small change in dielectric constant and dissipation factor over a wide range of temperature, even at very high frequencies, with outstanding dimensional stability, arc resistance and dielectric strength and mechanical properties. Dielectric qualities are retained to a very significant degree even after prolonged exposure to heat and high humidity. Hardened and chrome-plated steel molds are recommended for use with both 541 and 428. Some properties of both of these compounds are given below:

	541	428
Bulk factor	9–11	2.1–2.3
Mold temperature, °F	300–330	270–330
Molding pressure, psi	1000–2000	1000–1500
Mold shrinkage (cold piece from cold mold), in./in.	0.001–0.004	0.004–0.007
Specific gravity	1.91–1.95	2.14–2.16
Water absorption, 24 hr. @ 23° C., %	0.065–0.085	0.05–0.08
Heat distortion temperature, 264 psi, °F	400	350–400
Flammability	Non-burning	Non-burning
Ignition time*	>90 sec.	—
Burning time*	<90 sec.	—
Impact strength, Izod ft.-lb. in. of notch	.3–.5	0.35–0.45
Compressive strength, psi	23,000–28,000	16,000–20,000
Flexural strength, psi	11,000–14,000	6,000–9,000
Tensile strength, psi	4,000–7,000	3,000–4,000
Modulus of elasticity, psi	$1.8–2.2 \times 10^6$	$2.1–2.6 \times 10^6$
Barcol hardness	60–70	55–65
Arc resistance, sec.	60*	180*
Dielectric constant		
60 cycles	4.7–5.2	5.7–6.2
1 kc.	4.4–4.6	4.7–5.0
1 mc.	4.2–4.5	5.2–5.5
Dielectric strength, v./mil		
Short-time	350	350–400
Step-by-step	340	300–350
Dissipation factor		
60 cycles	0.02–0.04	0.04–0.05
1 kc.	0.01–0.015	0.027–0.032
1 mc.	0.013–0.018	0.017–0.020
Insulation resistance		
1 day, 95% R.H., 160° F., megohms	25,000–30,000	—
30 days, 95% R.H., 160° F., megohms	20,000–25,000	—
60 days, 95% R.H., 160° F., megohms	15,000–20,000	—

* According to MIL-M-19833(SHIPS), Amendment 3, Type GDI-30F material

Readers' Service Item 9

Also worth mentioning—

☐ A wide range of pearlescent shades of Escon polypropylenes, especially suited for the fabrication of cosmetic closures and containers, has been developed by Enjay Chemical Co.

Readers' Service Item 10

☐ Lexan 102, a new, nearly water clear polycarbonate designed for lenses, light covers, diffusers, etc., is available from the chemical materials dept. of General Electric Co. Improved clarity results from the use of additives masking the natural light amber color of Lexan and preventing darkening during molding. The new Lexan 102 has the same physical, electrical and chemical properties of previous grades of Lexan resins.

Readers' Service Item 11

☐ A vinyl resin for plastisol and high solids organosol dip coating and rotational and slush molding, Bakelite QXKV-2, is available from Union Carbide Plastics Co. In comparison with other vinyl plastisols, those based on this resin can be readily vacuum deaerated, will release air rapidly, and are less affected by humidity.

Readers' Service Item 12

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For more information check Readers' Service Card No. 128

New Equipment

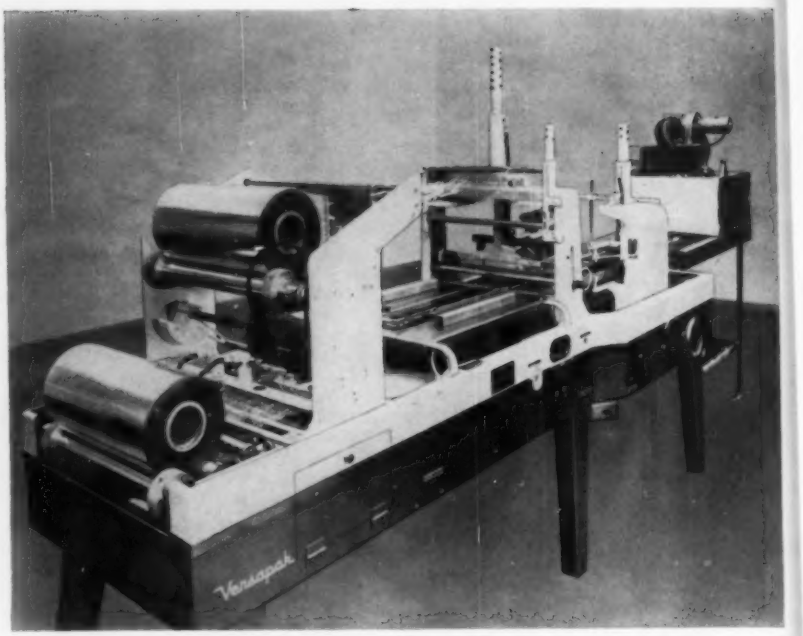
Contour packaging machine uses shrinkable film

Versapak, a high speed contour packaging machine that will overwrap products with shrinkable film up to 2,000 units per hour, has been developed by Versapak Film and Machinery Corp. The machine covers the product with shrinkable film, making perimeter seals of hairline thickness on four sides. The package travels through a shrink tunnel for four seconds, and emerges contour wrapped without wrinkles or folds.

The machine uses two rolls of films which are placed in racks. One wheel adjusts the machine to the package size. The machine will also accommodate non-shrink, heat-sealable film, in which case the tunnel passage is eliminated.

The H-150 perimeter sealer will seal packages 4-14 inches wide, 1/16-3½ inches high, and 3-14 inches long. It requires 0.51 cubic feet of free air at 80 psi. at machine.

Readers' Service Item 21



Versapak packaging machine.

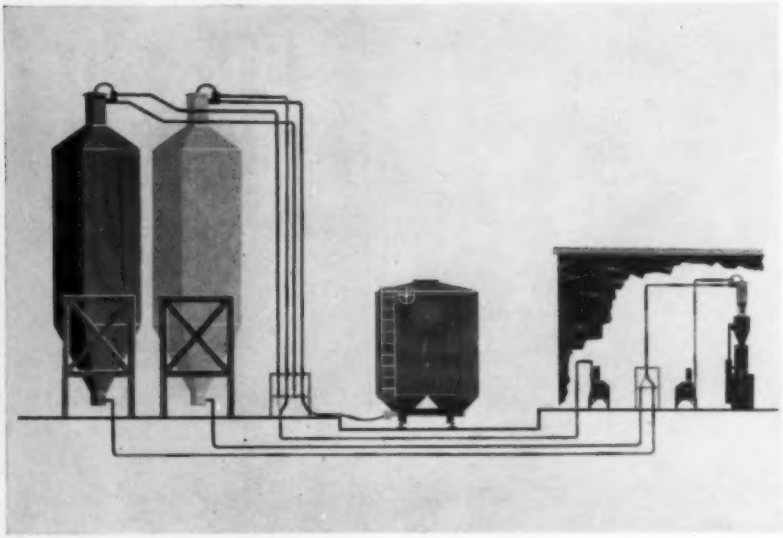


Diagram of vacuum conveying system.

Low-cost vacuum conveying system

A simple, low-cost vacuum conveying system for unloading bulk shipments of plastic materials is available from Whitlock Associates, Inc., in addition to its system for transferring material from storage to machine hoppers.

The system will automatically unload up to 8,000 pounds of material per hour. Distances up to 300 feet can be obtained at lesser rates.

Material is drawn to a vacuum hopper installed at the top of a silo. When the hopper is filled, the unit automatically shuts off, allowing the material to dump into the storage area. The unit then reverses itself to clean the filter in the hopper's cover. This cycle repeats until the material is completely unloaded or the silo is filled.

Readers' Service Item 22

For more information check Readers' Service Card (p. 79)

High temperature recording plasticimeter

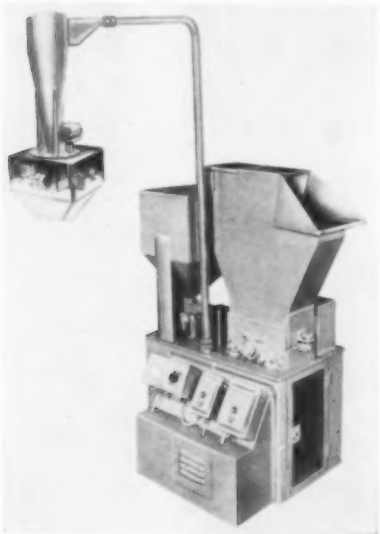
The high temperature recording plasticimeter called the Plasticorder has been developed by C. W. Brabender Instruments, Inc. The new instrument incorporates the C. W. Brabender Plastograph and measuring head of new design with a vertical mixing chamber and shaft and will accurately forecast and record plastic properties of materials up to 1150°F. The sample measuring head operates within a tube furnace and temperature uniformity is guaranteed so that the plasticity of materials can be measured at either constant or programmed temperatures from 575° to 1150°F.

Present owners of a Plastograph can modify their instrument with the new sample measuring head, tube furnace and controls. For others, the Plasticorder can be used as is and with an assortment of standard Plastograph measuring heads.

Readers' Service Item 23

Blending granulator and machine feeder

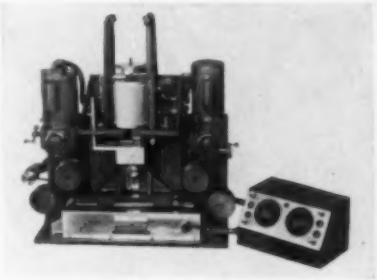
An improved version of its Blendomatic granulator, which mixes virgin material with regrind and then loads the mixed material into the hopper of an injection molding or extruding machine, has been introduced by Ball & Jewell, Inc. These granulators are available in four different capacities from 200 to 500 pounds an hour, with standard or wide throat hoppers, and will handle all thermoplastic materials. They are built completely of steel and feature heavy-duty knives with double-shear knife action.



Blendomatic granulator and feed to machine hopper

Up to 65 pounds of virgin material can be loaded into the rear hopper of these machines, from which an electric vibratory feed releases the material in the ratio desired for blending with the regrind. The mixture of regrind and virgin material travels to the hopper of the injection molding or extruding machine through conduit tubing where the material level is maintained automatically. A free-fall air separator provides an even flow of material and prevents dust during material discharge.

Readers' Service Item 24



Tinius Olsen monofilament tester

Monofilament tester

The monofilament tester announced by the Tinius Olsen Testing Machine Co. can provide 30 yards of 0.010-inch oriented monofilament in 20 minutes from only 10 grams of resin.

The new unit features a ram-type extruder that withstands forces as high as 100 lbs., and thermoregulated temperatures as high as 600°F., to permit close duplication of commercial extrusion conditions. Pressure is applied by fixing weights to the piston rod and dies are added either by dropping them into the extrusion chamber which has a retaining plate, or by substituting a die plate for the retaining plate. Constant volume displacement can be utilized to operate the ram extruder by connecting the piston rod to the jaws of a tensile testing machine.

In operation, the extrudate first passes through a water bath and then to a retarder roll. It is wound on a set of Godet rolls, passed through an orientation bath to a second set of Godet rolls which rotate faster than the first set, and is then wound on a take-up spool.

Readers' Service Item 25

Pilot thermoforming machine

Comet, Jr. is a low-cost thermoforming machine built by Comet Industries, Inc., for any company that wishes to make sample runs, product design, cost estimating, and evaluation of materials in connection with vacuum forming and packaging. The machine has automatic heating, draping, seal off, and application of vacuum at the proper instant for quality control.

Mold area is 10 x 10 inches; sheet size 11 x 11 inches; sheet thickness 0.001 to

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For more information check Readers' Service Card No. 130

0.125 of an inch; drape stroke 4 inches; and heater area 12 x 12 inches. The machine operates on a 110 volt line, space required is 16 x 32 x 41 inches high; 80 psi, compressed air required; drape pressure 80 lbs.; heater adjustment 4 inches; and, heater timing range 0-120 and 0-240 seconds.

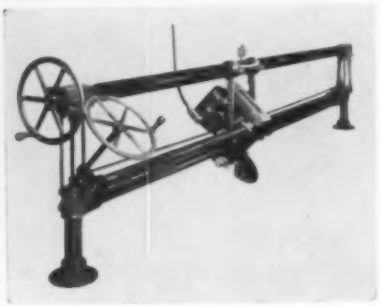
The machine comes complete with controls, vacuum system, vacuum regulator, vacuum filter, air regulator, filter and lubricator.

Readers' Service Item 26

Panel and sheet saws

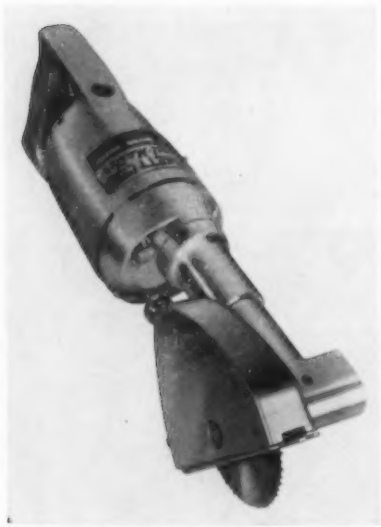
Kett Tool Co.'s KS-4AM hand saw will cut panel and sheet work as deep as one inch. The power saw features a blade safety guard. The spring powered guard, located in the blade housing, automatically drops over the blade when the saw is not in use, prolonging the blade life as well as preventing accidental personal injury.

The 3⅜-inch blades come with 60 and 80 teeth. The saw is powered by a 110 volt, ac/dc motor, and is equipped with ball bearings throughout.



Kett power saw.

Readers' Service Item 27



Hendrick model TR-M-14 panel saw.

Another saw for cutting acrylic, phenolic, and laminated panels has been developed by Hendrick Mfg. Corp. By assuring rigidity with a three-inch steel tube third rail, the Tri-Rail saw can cut stock up to 14 feet with a high degree of accuracy.

The saw is supplied in manual and automatic models, designated TR-M and TR-A. A standard, automatic, 14-foot capacity cutter requires only 15 feet of shop space, since the stock is stationary during cutting.

Readers' Service Item 28

Bucket elevator for hoppers

Bucketlift Jr., a compact bucket elevator for simplified, automatic loading of injection molding or extruding machine hoppers has been introduced by M-H Standard Corp. It is available in housings of steel, aluminum, or stainless steel and 2½, 5, and 10 foot body sections may be combined to make elevators up to 30 feet high. The front panel of the unit is removable in sections to expose the entire belt for inspection and cleaning.

Powdered or granular material is loaded into the inlet hopper 25½ inches above the floor. The material is conveyed to the height of the elevator, at which point it is automatically dumped into the hopper of the molding or extruding machine. Up to 15,000 pounds per hour of material may be handled. A vibrator can be added to the inlet hopper if the material being used is not free flowing.

Readers' Service Item 29

Also Worth Mentioning

☐ An automatic, fill, wipe and polish machine, Model FWP-40, for finishing dials, control knobs, nameplates and clock faces is available from Conforming Matrix Corp. It applies paint and dial fillers, wipes, and polishes at rates of up to 2500 parts per hour.

Readers' Service Item 30

☐ A movable XY strip chart recorder, which quickly converts standard universal testing machines into specialized units, has been announced by Tinius Olsen Testing Machine Co. Plugged into any machine equipped with an adapter unit, the recorder can be used for a wide variety of functions including stress-strain curves using electronic instrumentation.

Readers' Service Item 31

☐ Ten sizes of self-contained strip heaters, in lengths from 20 to 120 inches and in widths from 2⅜ to 6⅛ inches, for hot veneering laminated plastic edges to core material are available from the Grace Fabri-Tool Co. All sizes are available for 180° or 200° F. temperature and may be plugged into any 115 volt outlet since they require no transformer or variable rheostat.

Readers' Service Item 32

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For more information check Readers' Service Card No. 131

Plastic Applications

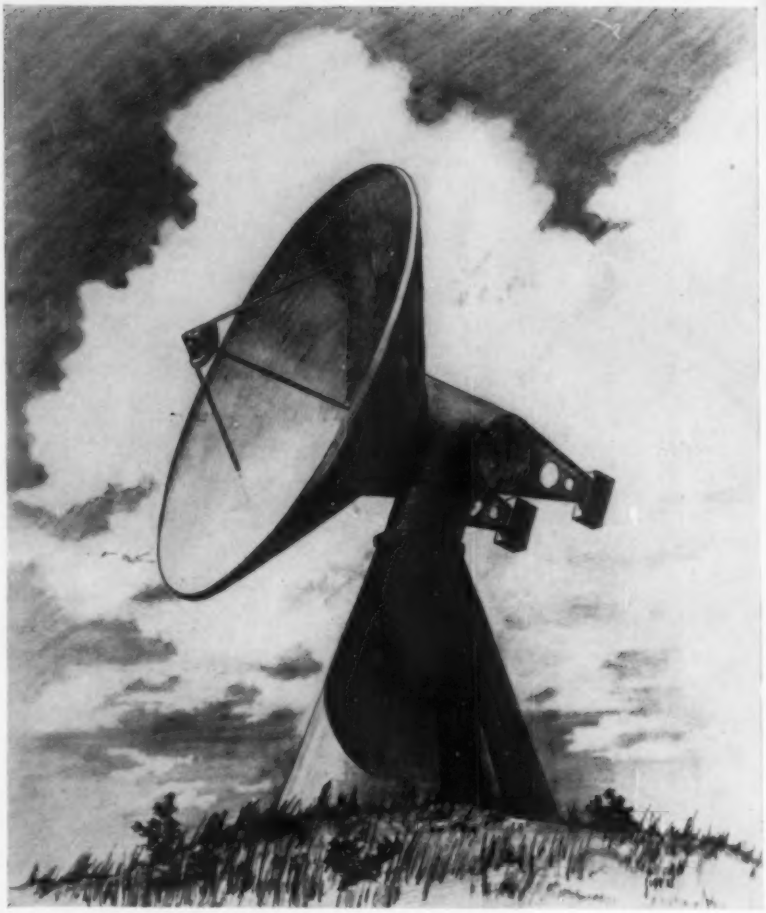
RP antenna reflectors

Close tolerance, reinforced plastic antenna reflectors which can be used to measure radiation from other planets, track satellites, or transmit and receive long range communications have been developed by Boeing Co. The dish-shaped reflectors catch radio waves and concentrate them on a receiver probe.

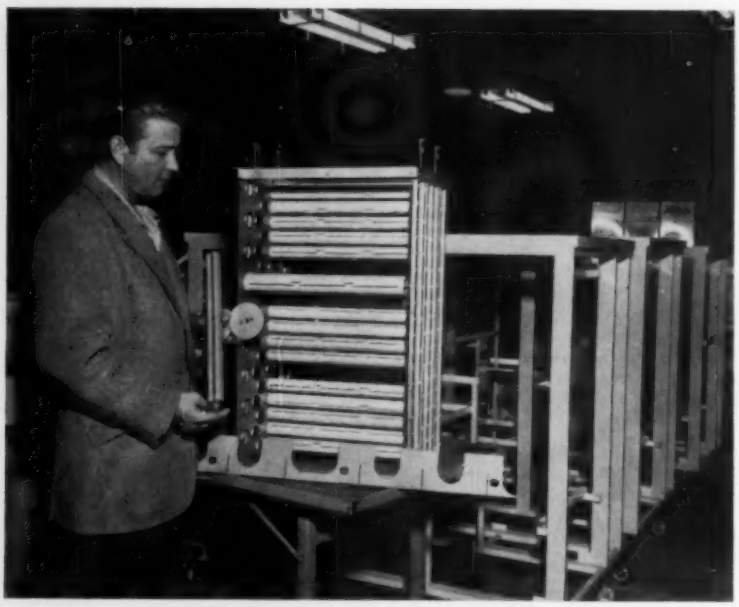
In the design, fiberglass-reinforced laminate is formed and cured on a pattern, and then filled with polyurethane foam. The surface is then coated with a reflective metallic finish, applied as metallic paint or adhesive metal foil. Surface tolerance is 0.005 inch.

Unlike sheet metal reflectors, which require automatic jacks to maintain smoothness, the Boeing design will not warp under sunlight, severe cold, or high wind pressures.

Readers' Service Item 41



Boeing-designed radio antenna reflector.



Drying section of Rapi-Dex x-ray processor.

X-ray processor components

A phenolic laminate has been selected for use in the drying section of a medical and industrial x-ray processor. The long tubes pictured, with longitudinal slits to emit drying air, are made of paper-base phenolic laminate. Rapi-Dex Co. first considered stainless steel for the parts that are contacted by chemicals from the processing liquids, but selected Westinghouse Micarta laminate because it was equally corrosion resistant, but less expensive.

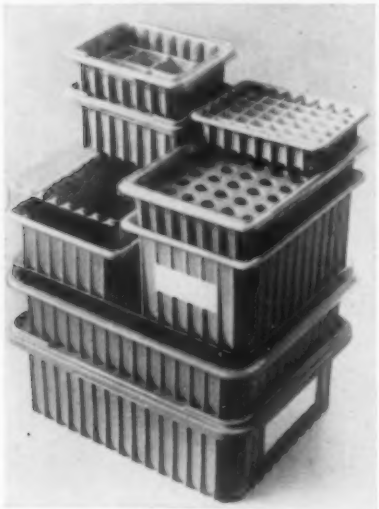
The drying area of the automatic processor delivers dry film in six minutes. It consists of 72 tubes of Grade 90 Micarta, each 17 inches long. Fifty-four of the tubes have diameters of 1⅞ inches and 18 have diameters of 1⅝ inches.

Readers' Service Item 42

For more information check Readers' Service Card (p. 79)

ABS modules for parts storage and handling

The Modubox system of Hollywood Plastics, Inc., is a standardized series of light-weight boxes made of heavy-duty ABS plastics, said to be particularly useful for the storage and handling of critical parts with a maximum of safety and a minimum of recovery time on the assembly lines of aero-space plants. Moduboxes are manufactured in eight standard styles in over 60 sizes in a variety of depths, with dividers, insert trays, and air tight covers to fit all sizes. Lips on the sides of the boxes make them adaptable to storage in racks without the need of shelves. The boxes stack without damage to contents and provide for dust free storage.



Standardized boxes for parts handling.
Readers' Service Item 43

Compact plastic trailer

A compact camping trailer of non-rusting, impact resistant reinforced plastic has been placed on the market by Barton Industries of North Long Beach, Calif. Towhee is molded of glass fibers and Vibrin polyester resin. It has a streamlined shape and is under nine feet long. The interior of the trailer, reached by swing-up doors on either side, is a sleeping area for two. Built into the rear of the trailer and protected by a door which lifts up to provide shelter and shade is a cooking area. The trailer also has a 14-cubic foot storage area, an electrical system for interior and running lights, full insulation and a torsion-rubber suspension system which can be adjusted for road clearance.

Readers' Service Item 44

Reinforced plastic trailer sleeps two.

Wire-reinforced foam flotation

An expanded polystyrene foam cylinder reinforced with galvanized mesh wire has been developed by Cell-Foam, Inc., for floating barges, docks, and boat houses.

The one-pound density barrel is 30 inches high and 24 inches in diameter. Molded around the perimeter of the barrel, just beneath the skin, is 14-gage galvanized steel 4 x 4 mesh wire for reinforcement.

Each 12-pound foam cylinder will support 480 pounds of dead weight.

Readers' Service Item 45

Marine safety equipment

A line of U. S. Coast Guard approved life floats and buoyant apparatus, marketed by Marine Safety Equipment Corp., reportedly achieves fire resistance and durability through the use of Hetron polyester resin. The equipment consists of fiberglass-reinforced Hetron, a product of Durez Plastics division, Hooker Chemical Corp.

Four floats, the smallest accommodating ten persons and the largest 20 persons, comprise the line. Standard color is orange.

Readers' Service Item 46

Jiffy Meter-Matic calf feeder with expanded polystyrene housing.

Calf feeder housing

Expandable polystyrene is custom molded by Weber Plastics, Inc., for the Jiffy Meter-Matic calf feeder housing. The foam holds the food at the proper temperature, while the feeder keeps it in solution and meters it out in economic quantities.

Readers' Service Item 47

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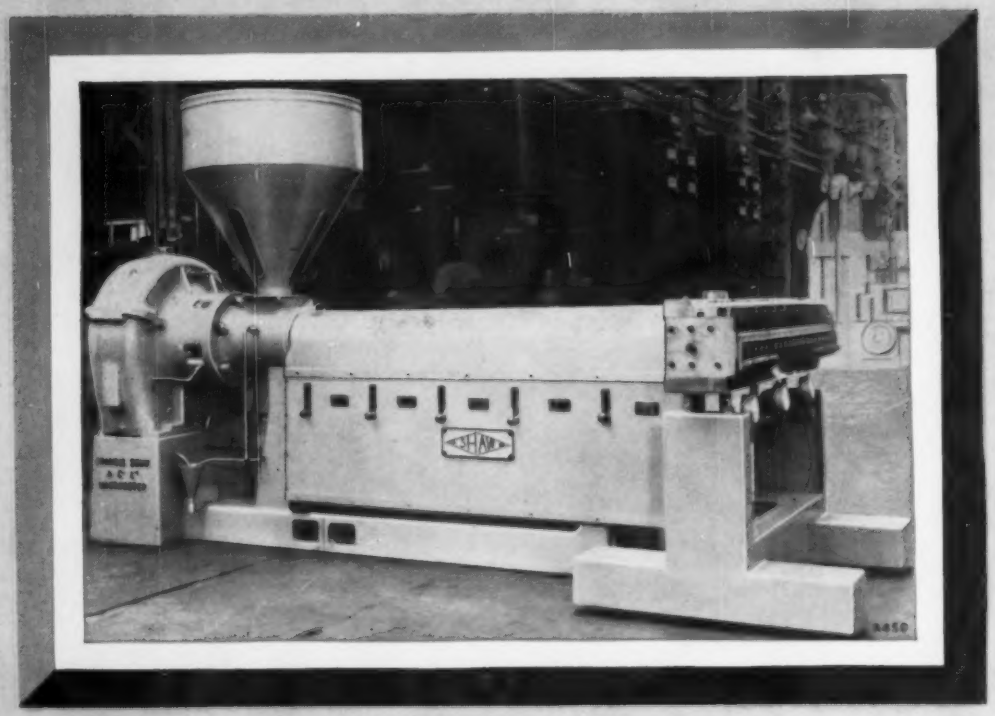

The new Francis Shaw P.4½" extruder for high impact polystyrene sheeting represents a completely modern approach embodying all the latest techniques.

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OVERSEAS AGENTS THROUGHOUT THE WORLD

PM553

For more information check Readers' Service Card No. 133

Reinforced acrylic panels

Naugatuck Chemical division, U. S. Rubber Co., is marketing two forms of acrylic panels for outdoor architectural applications. The panels are made of a special acrylic resin reinforced with glass fibers and press laminated.

The flat sheet panels, called Tropiglas, are made in 20 colors and white, in sizes up to 4 by 10 feet, and in thicknesses from 0.060 to 0.100 inch. The sandwich panels, made in five basic patterns with sizes up to 4 by 10 feet, are called Tropicel.

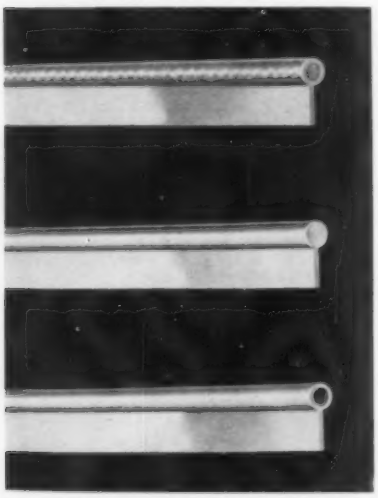
Church windows and similar glazing applications are a major use for the sandwich panels. Other uses include luminous ceilings, light transmitting curtain walls, doors, partitions, and privacy panels. The flat sheet panels can be used for many of the same applications, plus industrial glazing.

Readers' Service Item 48

Vinyl lip welt

Sackner Products, Inc. has available vinyl lip welt in 119 stock colors or in any special color required and in a wide selection of styles; including hollow, solid, or wire reinforced bead in plain, split lip, serrated, or cut lip designs. No filler of any type is used in the vinyl compound and the lip welt is also available in clear vinyl with metallic or fiber braid encased in the plastic bead for special effects. All styles are available in a wide range of sizes and Sackner can produce the material in any hardness desired and from special compounds resistant to low temperatures.

Lip welt is used in furniture upholstering, seat covers, boat interiors, luggage, handbags or wherever leather, plastic or fabric requires a finished edge.



Three styles of vinyl lip welt.

Readers' Service Item 49

PE boxes keep missile components clean.

PE boxes for precision parts storage

Linear polyethylene plastic boxes are being used for uncontaminated handling of electronic and mechanical components used in missiles and high speed aircraft guidance systems. The new boxes, injection molded by Plastic-Ware, Inc., were developed jointly by the Eclipse-Pioneer division of Bendix Corp. and Plastic-Ware, with technical assistance from Celanese Polymer Co., producer of the Fortiflex polyethylene used.

The boxes combine the toughness and durability of linear polyethylene with a high degree of launderability. They can be washed repeatedly with detergent and water or steam at 180-200°F. Since they are chemically inert, they can also be subjected to vapor degreasing.

The boxes are 15 inches square and come in two-inch and four-inch depths. Rigid plastic strips are used to establish inner compartments. The dust proof lids can be interchanged, and feature a raised edge which facilitates stacking.

Readers' Service Item 50

Durable, low cost, "Form Fit" chairs of polypropylene

Attractive and exceptionally durable "Form Fit" contour chairs, a side chair and an arm chair in a broad range of popular colors, are being made by Alladin Plastics, Inc. from polypropylene plastic of AviSun Corp. The chairs, which are injection molded in a special 800-ton injection molding machine made for Alladin by National Automatic Machine Co., will not chip, crack, rust or peel, and resist abrasion and stuffing. Due to the unique properties of polypropylene, the chairs flex just enough to comfortably "form fit" anyone regardless of size or weight and thus have the comfort and "give" of an upholstered chair.

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For more information check Readers' Service Card No. 135

Flexible, strong polypropylene contributes unique comfort and durability to "Form Fit" chairs.

In addition to exceptional durability, these polypropylene chairs are very weather resistant, are thus excellent for outdoor use; they resist staining and extremes of temperature; they provide unique comfort with ease of maintenance; and they are very light in weight and are of good contemporary design. Designed to satisfy multiple uses in the home, the Alladin chairs are equally ideal for hotels, motels, restaurants, waiting rooms, offices, schools and hospitals. The molded-in colors will not fade in normal use and the chairs are both rot and mildew proof. Nearly impossible to stain, they resist alcohol, nail polish remover, lighter fluid, oils and greases. In addition they are easily cleaned with soap and water.

The chairs are appropriately fitted with tapered tubular steel legs and cross-braced to offer the greatest stability. Finished by a special electrolytic bonderizing process the legs are chip and rust proof.

Before Alladin marketed these new "Form Fit" chairs, they were put through a torture test designed to simulate the abuse given a chair during the normal seating process, but to a much greater degree. A 165-pound weight was dropped on the seat of the chair while at the same time it was bent backwards. After running this test 135,000 times on the polypropylene chair there was no noticeable wear so that it was concluded that the chairs will survive a lifetime of normal use.

Readers' Service Item 51

Reinforced polyester resin aircraft outer body

Avian 2/180 plastic body gyroplane.

The entire outer body of the Avian 2/180 gyroplane is made of glass fiber-reinforced, fire-retardant Hetron polyester resin because of this material's strength, light weight, and resistance to fatigue. The gyroplane was designed and built by Avian Aircraft Ltd. of Canada and combines elements of helicopter and gyroplane design.

Use of the polyester-glass fiber material eliminated expensive tooling and panel work on the multiple-curved surfaces of the fuselage and at the same time provided the minimum dead weight consistent with safety. The Hetron polyester resin used is a product of Durez Plastics Div., Hooker Chemical Corp.

Readers' Service Item 52

Also worth mentioning—

☐ Ultraviolet absorbent filter tubes for shielding valuable documents and art treasures from the damaging effects of ultraviolet light emitted by fluorescent lamps have been developed for the Smithsonian Institute and the Bureau of Archives, Washington, D. C. The tubes are slipped over the fluorescent lamps and the special grade of acrylic plastic absorbs the radiation emitted in the ultraviolet range without affecting the quality of the visible light. The Rohm and Haas Plexiglas tube also offers light weight, breakage resistance, dimensional stability, and minimum maintenance requirements. The tubes are extruded by Westlake Plastic Co.

Readers' Service Item 53

☐ ABS plastic tote boxes capable of carrying a 300-pound load are being made by General American Transportation Corp. for mechanized post offices in Washington, D. C. and Detroit, Mich. Each is 27½ by 17½ by 9⅜ inches deep and weighs about 9½ pounds. The boxes were developed in connection with postal officials and the conveyor systems' manufacturer and are the latest step in developing a light, strong container to carry publications and other heavy materials on automated mail-handling systems.

Readers' Service Item 54

☐ Three hinged foam pads which fit in the corners of shipping cartons are reported to shockproof any fragile item up to 25 pounds in weight. Pac-Trim corners, produced by Pac-Tron Inc., are coated with a water-activated adhesive for firm anchoring. Eight hinged pads are needed per package.

Readers' Service Item 55

☐ A line of 11 vinyl covered loose-leaf notebooks is manufactured by the vinyl case division, Peterson Electronic Die Co. Thanks to a new process, the bindings are loosely wrapped for better feel, but will not wrinkle.

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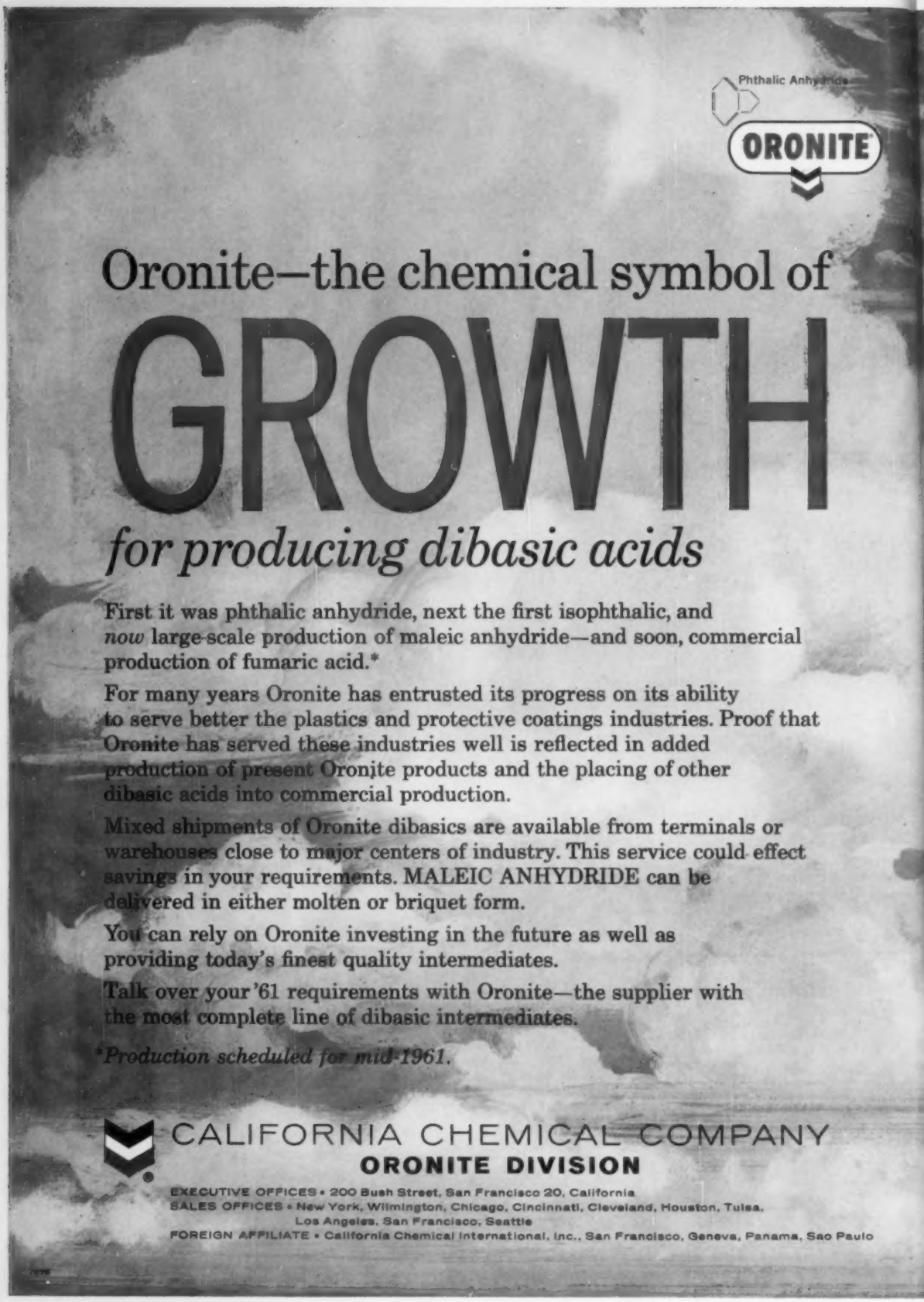
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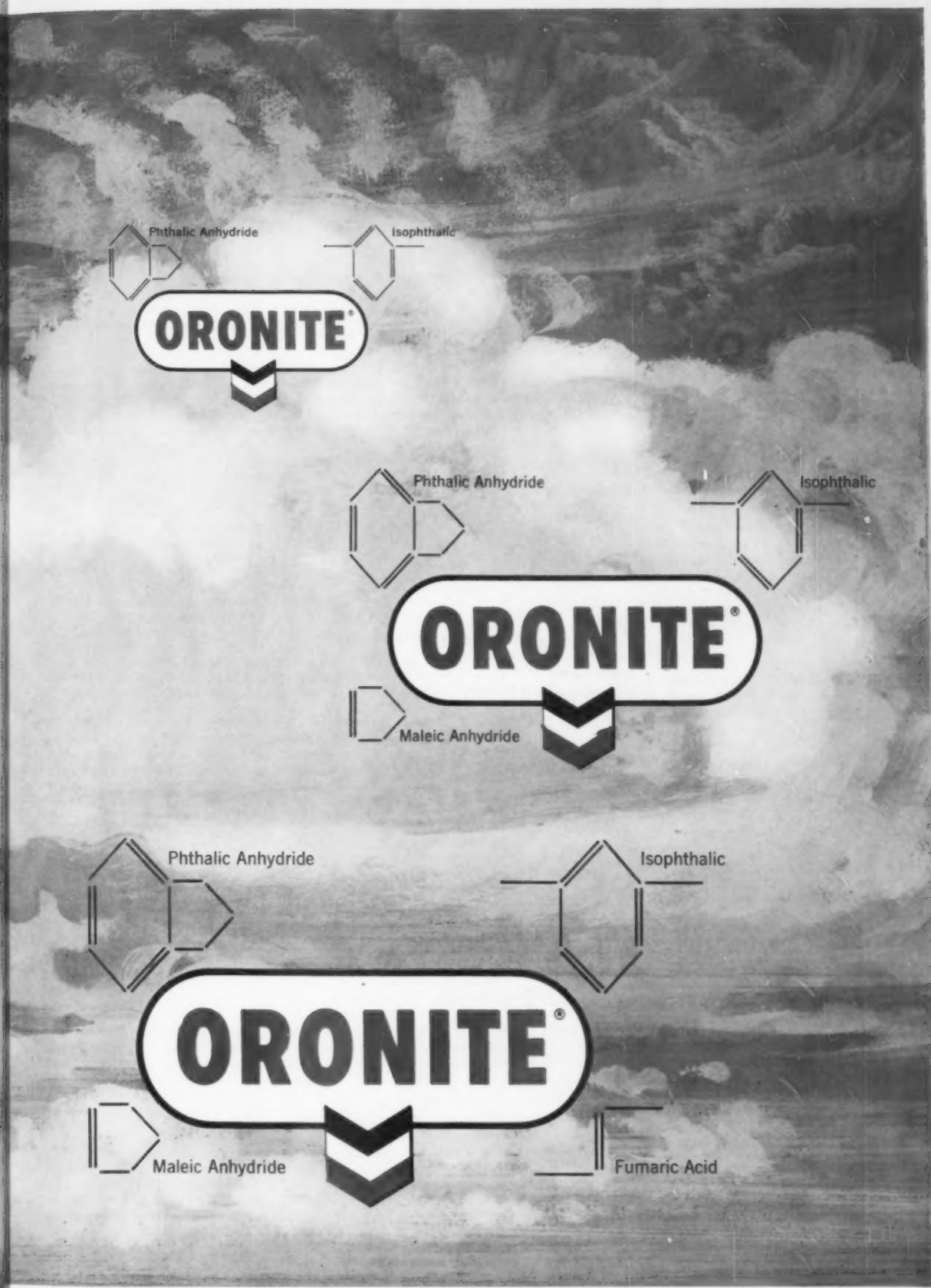

For more information check Readers' Service Card No. 137

New Literature

For more information check Readers' Service Card (p. 79)

"Airco Organic Chemicals and Colton Polymers." Air Reduction Chemical & Carbide Co. 8 pages. Lists properties and applications of a large group of products, including calcium carbide, pipeline acetylene, and special purpose resins. Also available in two abbreviated versions, one covering only polymers, and the other chemicals.

Readers' Service Item 61

"Air-Operated Diaphragm Valves." Bulletin 134-A. Hills-McCanna Co. 6 pages. Data on eight types of air operators, for valves from through 12 inch sizes. Includes sectional drawings, descriptive information, tables of air actuator pressures for various line pressures, and dimensional data.

Readers' Service Item 62

"Morflex Specialty Plasticizers." Data Sheet No. 560. Chas. Pfizer & Co., Inc. 9 pages. Properties of four plasticizers are compared with those of DOP. Summaries of tentative specifications and properties, and of typical performance in vinyl films.

Readers' Service Item 63

"Dynel Overlays for Glass-Reinforced Plastics." Form T-2045. Textile fibers department, Union Carbide Chemicals Co. 8 pages. Enumerates advantages of protecting laminates with Dynel overlays. Latter noted for water, abrasion, chemical, and fire resistance.

Readers' Service Item 64

"The Super Tumblast." Catalog No. 162-D. Wheelabrator Corp. 28 pages. Describes line of batch-type, airless, abrasive blast cleaning machines with the aid of photographs, cross section and exploded views, and drawings.

Readers' Service Item 65

"Stretch-Pak Display Packaging." Nevins Co. 4 pages. Defines and illustrates packaging services and operations.

Readers' Service Item 66

"Plastics and Other Materials for Science and Industry." Bel-Art Products. 40 pages. Catalog of a wide variety of products.

Readers' Service Item 67

"Pfaudlon 301." Bulletin 1007. Pfaudler Co. 4 pages. Description, corrosion resistance, physical characteristics, and application of a medium priced, corrosion resistant coating for metal. The coating is based on a chlorinated polyether.

Readers' Service Item 68

"Literature on Nacreous Pigments." Mearl Corp. Includes four separate bulletins — Nacreous Pigment Handbook, Coating with Nacreous Pigments, Murano Colors, and price list. Wide range of data on nacreous pigments.

Readers' Service Item 69

"Organic Peroxides." Lucidol division, Wallace & Tiernan, Inc. 12 pages. Supplies application and physical property information.

Readers' Service Item 70

"Plasti-Cube Package Systems." Bulletin PC-101. Young Machinery Co. 4 pages. Describes and illustrates package systems for handling plastic cubes, pellets, chips, etc.

Readers' Service Item 71

"Plexiglas Replacement Window Glazing." PL-465. Rohm & Haas Co. 8 pages. A manual for those concerned with reglazing or new constructions, it covers properties of acrylic sheet and its advantages in glazing. One section describes methods of installation of the glazing sheet.

Readers' Service Item 72

"Lexan Polycarbonate Films." CDC-396. Chemical Materials department, General Electric Co. 13 pages. This technical report details the physical and electrical properties of polycarbonate films, compares extruded and solvent cast films, and lists suggested applications.

Readers' Service Item 73

"Plastic Glazing for Aircraft." Bulletin No. 200-61. Swedlow Inc. 4 pages. Reviews latest developments in production and application of plastic glazing, particularly for military and commercial aircraft.

Readers' Service Item 74

"Alcohols." Union Carbide Chemicals Co. 80 pages. Contains comprehensive data (properties, constant-boiling mixtures, specifications, test methods, etc.) on 21 alcohols, from methanol to tridecanol. Sections on alcohols for chemical specialties and coating, and performance of plasticizers.

Readers' Service Item 75

"Flexiphen 160—Polymethylene Polyphenol." Bulletin PD 105. Tar products division, Koppers Co., Inc. 10 pages. Introductory information, chemical structures, formulations, reaction products, and properties of this material.

Readers' Service Item 76

"Brochure" Chanal Plastics Corp. 12 pages. Describes vacuum forming, pressure forming, and blow molding services.

Readers' Service Item 77

"Modern Presses—Hydraulic." French Oil Mill Machinery Co. 32 pages. Catalog of hydraulic presses and equipment. Specifications and photographs. Tables of data, including saturated steam table, superheated steam table, J.I.C. standards, and others.

Readers' Service Item 78

"Silicones." CDS-219C. Silicones products department, General Electric Co. 8 pages. Photos and data on silicone fluids, protective coatings, electrical insulation, and rubber. Products grouped under end-use headings.

Readers' Service Item 79

"Electromatic Universal Testing Machines." Bulletin 63. Tinius Olsen Testing Machine Co. 36 pages. Catalog of two screw and four screw testing machines. Provides detail, specifications, and information on unique features.

Readers' Service Item 80

"Controlled Speed Systems." Form F-1952. U.S. Electrical Motors Inc. 8 pages. Reports on advances made in central control instrumentation and panel design, and in signal transmission methods within process-controlled automatc systems.

Readers' Service Item 81

"How Silicones Aid the Rubber Industry." Reference 1-120 Dow Corning Corp. 8 pages. A production engineering guide to silicones most useful in the production of rubber and plastic materials and in the manufacture of parts.

Readers' Service Item 82

"12-20 Ounce Screw and Plunger Type Injection Molding Machines." Bulletin 601. Watson-Stillman Press division, Farrel-Birmingham Co. Inc. 4 pages. Covers design feature, complete specifications, and die space dimensions.

Readers' Service Item 83

Book Reviews

"Making Better Plastic Welds." Donald W. Thomas. Laramy Products Co., Cohasset, Mass. Paper, 6 by 9 inches, 56 pages. $1.00.

This instruction book on the welding of modern structural plastics is intended as an aid in the training of presently active plastic welders as well as novices. A completely practical manual, it keeps history and theory at a minimum. It provides complete instructions on how to produce the different types of welds used for plastics, as well as techniques for testing the quality of the welds. Directions for preparing five test samples conclude the brochure.

Chapters cover the special techniques of molding specific materials, as well as the techniques for welding in general. Diagrams illustrate such basic information as methods of repositioning grip on the rod without releasing pressure. Two tables, one providing data on optimum conditions for welding specific thermoplastics and the other listing recommended rod sizes and approximate number of beads required for butt welding sheet, are particularly helpful.

Although this little book does not provide the theory some others include, it is well worth its small cost.

"Plastic Foams—Storage, Handling, and Fabrication." Safety Guide #5. Manufacturing Chemists' Association Inc., 1825 Conn. Ave., N.W., Washington 9, D. C. $0.20.

According to this report, fire-safe storage of plastic foams calls for no special precautions beyond those typically afforded piles of lumber and other such combustibles. The ignition properties of plastic foam are no more hazardous than those of other common solids.

Reasonable safeguards and good housekeeping practices, such as are desirable in the handling, storage, and fabrication of other common solids, are necessary with foams to avoid ignition. Traces of a hydrocarbon blowing agent in foams lowers the flash ignition temperature 200-300 degrees. However, this is still well above the temperature of potential ignition sources such as steam lines, hot water pipes, molten tar, etc.

Thermoplastic foams tend to melt away from the sources of heat, thus lowering chances of ignition. Flexible urethane foams will not ignite spontaneously if the proper catalyst systems are used. Inasmuch as the various blowing agents are toxic to varying degrees, ventilation must be adequate.

In case of fire, flames should be doused with water or smothered.

"Plastics for Architects, Artists, and Interior Designers." Armand G. Winfield. Society of Plastics Engineers, Inc., 65 Prospect St., Stamford, Conn. Paper, 8½ x 11 inches, 50 pages. $2.00.

An illustrated survey of some of the best uses of plastics in the building and decorative fields, this interesting booklet discusses plastics from the aesthetic point of view. It is divided into two sections, one on thermosetting and the other on thermoplastic resins. The illustrations in both sections are outstanding.

The paper on thermosetting was presented at the Fifteenth ANTEC, and the one on thermoplastics at the Sixteenth ANTEC. However, the inclusion of the photographs makes them read like more than merely reprinted papers.

"Spray-In-Place Shelters." A. F. Gurdo. PB 161 780, OTS, U. S. Department of Commerce, Washington 25, D. C. 30 pages. $1.00.

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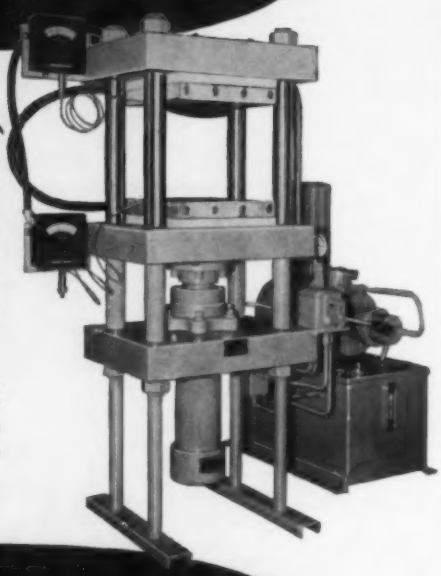

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Rigid, reinforced plastic shelters suitable for storing a wide variety of materials and equipment can be quickly erected in remote areas with a minimum of manpower, tools, and cost, using a spray-in-place technique developed by the Air Force. The technique employs mechanical depositors which spray resin and glass onto the mold surface. Thoroughly wetted glass fiber with catalyzed and promoted resin can be sprayed onto the mold quickly and uniformly with a minimum expenditure of time and material. Filler or extender materials can be added to the spray, if needed. A quonset-shape inflatable mold was used in the tests, but the process is applicable to any shape or type mold. The spray mixture was made from commercially available stocks of glass fiber.

Tests showed that most commercial polyester can be used as purchased or can be easily modified for use with mechanical resin depositors. Test shelters withstood winds over 90 mph. with supporting guys, and nearly 60 mph. without guys.

"Manual of Man-Made Fibers." C. Z. Carroll-Porczynski. Chemical Publishing Co., Inc., 212 Fifth Ave., New York 10, N. Y. Cloth, 5½ by 8¾ inches, 304 pages. $10.00.

This manual attempts to summarize technical information on the most important man-made fibers. It is organized for efficiency, presenting data in tables and figures. It provides chemical base, physical and chemical properties, stress-strain curves, dyeing method, identification test, and producer for each fiber.

Three main sections cover natural polymer man-made fibers, synthetic polymer man-made fibers, and inorganic fibers. Manufacture of the individual fibers within each category is illustrated by means of flow charts. A chapter on crimping illustrates the methods of crimping, types of crimped yarn, and stress-strain curves of crimped yarn.

Photomicrographs of longitudinal and cross sections and X-ray diffraction photographs provide means of fiber identifications. A comprehensive bibliography, arranged by fibre, concludes the volume.

"Synthesis of Resorcinol-Epoxy Adhesive and Evaluation of its Mechanical Properties." H. T. Lee and others. PB 161 785, OTS. U. S. Department of Commerce, Washington 25, D. C. 10 pages. $0.50.

This bulletin presents procedures for synthesizing a resorcinol-epoxy resin which when used as an adhesive gave shear strengths of approximately 1,570 psi. at 73° F., and 2,110 psi. at 160° F. With this resin, an average impact strength of 16.8 ft. lbs./0.75 sq. in. of bonded area was obtained at both temperatures, and 16.4 ft.-lbs./0.75 sq. in. at —65° F. when bonding steel to steel. Although a room temperature cure can be accomplished using 8.2 parts diethylene triamine curing agent per hundred parts or resin, the rise in shear strength at 160° F. indicated that an elevated temperature cure would be more effective in achieving the maximum adhesive properties of this material.

Patent Digest

Materials

Polyesters Extended with Diallylidene Pentaerythritol and Compositions Containing Same. No. 2,974,116. J. A. Parker, H. R. Ready, and J. Versnel, Lancaster County, Pa. (to Armstrong Cork Co., Lancaster, Pa.).

Solid State Polymerization. No. 2,976,262 and 2,976,263. Y. Jen, Anaheim, Calif, and J. L. Johnson, New Brunswick, N. J. (to American Cyanamid Co., New York, N. Y.).

Rapidly Hardenable Mixtures of Epoxy Resins and Polyamide Resins. No. 2,977,332. H. Zumstein, Basel, Switzerland (to CIBA Ltd., Basel, Switzerland.).

Composition of Matter Comprising a Vinylidene Chloride Copolymer and a Plasticizer. No. 2,977,335. C. B. Havens, Midland, Mich. (to Dow Chemical Co., Midland, Mich.).

Polymerization of Olefins. No. 2,977,350. E. V. Fasce and J. K. Mertzweiller, Baton Rouge, La. (to Esso Research and Engineering Co.).

Glass Fabric Reinforcement for Plastics. No. 2,975,503. C. E. Bacon, Darien, Conn. and M. T. Nemeyer, E. Chester, N. Y. (to Owens-Corning Fiberglas Corp.).

Method of Coating a Polymeric Thermoplastic Dielectric Film and Article Produced Thereby. No. 2,976,184. P. S. Blatz, Buffalo, N. Y. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Coated Polymeric Thermoplastic Dielectric Film. No. 2,976,185. R. T. McBride, Buffalo, N. Y. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Adhesive Composition, Methods of Employing It, and Laminating Structures. No. 2,976,203 and 2,976,204. H. C. Young and W. W. Toy, Philadelphia, Pa. (to Rohm & Haas Co., Philadelphia, Pa.).

Plastics Molding Materials and Processes. No. 2,982,744. J. L. Voigt, Arnhem, Netherlands (to N. V. Onderzoekingsinstituut Research, Arnheim, Netherlands).

Redispersible Dispersion of Polytetrafluoroethylene. No. 2,976,257. H. J. Dawe, Port Huron, Mich. and E. L. Youse, Berkeley Heights, N. J. (to Acheson Industries, Inc., Port Huron, Mich.).

Composition Comprising a Polyepoxide and Divinylbenzene Dioxide. No. 2,982,752. B. Phillips, Charleston, and C. W. McGary, Jr., and C. T. Patrick, Jr., S. Charleston W. Va. (to Union Carbide Corp.).

Continuous Bulk Polymerization Process. No. 2,982,758. C. L. Michaud, Springfield, N. J. (to Celanese Corp. of America, New York, N. Y.).

Synthetic Elastomers. No. 2,982,759. R. O. Heuse, Beaumont, Tex. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Process for Spinning Vinyl Resin Solution. No. 2,982,760. D. Maragliano and E. Cernia, Milan, Italy (to Soc. Polymer, Industrie Chimiche, Milan, Italy).

Continuous Polymerization of N-Vinyl Lactams. No. 2,982,762. J. F. Voeks and T. G. Traylor, Concord, Calif. (to Dow Chemical Co., Midland, Mich.).

Manufacture of Grafted Polymers. No. 2,983,657. J. Gabilly, L'Hay-les-Roses, and M. Jobard, Paris, France (to Compagnie de Saint-Gobain, Paris, France).

Preparation of Expandable Ethylenically Unsaturated Polymer Particles and Cellular Products Therefrom. No. 2,983,692, G. F. D'Alelio, Pittsburgh, Pa. (to Koppers Co., Inc.).

Polymeric Compositions and Their Method of Manufacture. No. 2,983,696. Stanley Tocker, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Shaped Resins. No. 2,985,604. J. O. Koehler, Parma, O., and H. Lamprey, Lewiston, N Y. (to Union Carbide Corp.).

Composition of Matter Comprising a High Molecular Weight Polymer and an Acetal or Ketal of a Hydroxycarboxylic Acid. No. 2,985,536. W. Stein and W. Offerman, Dusseldorf-Holthausen, Germany (to Dehydag, Deutsche Hydrierwerke G.m.b.H., Dusseldorf, Germany.

Printed copies of patents are available from the Commissioner of Patents, Washington 25, D. C. Prices, 25c each.
—The Editor

Cross-Linking of Copolymers of Ethylene and Propylene. No. 2,983,714. A. E. Robinson, Newark, and W. D. Willis, Wilmington, Del. (to Hercules Powder Co., Wilmington, Del.).

Polymeric Sanitary Coating System. No. 2,985,600. N. F. Barr, Pine Twp., and Frank G. Alster, Baldwin, Pa. (to American Marietta Co. Stoner-Mudge Co. Division, Chicago, Ill.).

Composition Comprising a Phenolic Novolac, a Phenolic Resol, and a Diallyl Phthalate. No. 2,985,614. E. M. Bright, N. Hollywood Calif. (to Air Logistics Corp.).

Blends of High Density and Low Density Ethylene Polymers and Films Thereof. No. 2,983,704. M. J. Roedel, Wilmington, Del. (to E. I. du Pont de Nemours & Co., Wilmington, Del.).

Curable Epoxy Compositions and Resins Made Therefrom. No. 2,985,616. C. W. McGary, Jr., and C. T. Patrick, Jr., S. Charleston, W. Va. (to Union Carbide Corp.).

Stabilized Polymer of 2 to 3 Carbon Atoms. No. 2,985,617. I. O. Salyer and A. S. Kenyon, Dayton, O. (to Monsanto Chemical Co, St. Louis, Mo.).

Light Stabilized Polyamide. No. 2,985,621. J. Brandes, Wiesbaden, and R. Gewehr, Obernburg (Main), Germany (to Vereinigte Glanzstoff-Fabriken AG., Wuppertal-Elberfeld, Germany).

Polymerization of Ethylene with Organoboron Compounds Treated with Oxygen. No. 2,985,633. F. J. Welch, S. Charleston, W. Pa. (to Union Carbide Corp.).

Preparation of Cellular Polyurethane Resins. No. 2,981,700. E. E. Parker, Allison Park, and K. H. Coultrap, Pittsburgh, Pa. (to Pittsburgh Plate Glass Co. Allegheny Cy., Pa.).

Production of Vinyl Chloride. No. 2,981,764. H. Le Bihan, Liege, and J. A. R. O. L. Godart, Tilff, Belgium, (to Societe Belge de l'Azote et des Produits Chimiques du Marly Renory-Ougree, Belgium).

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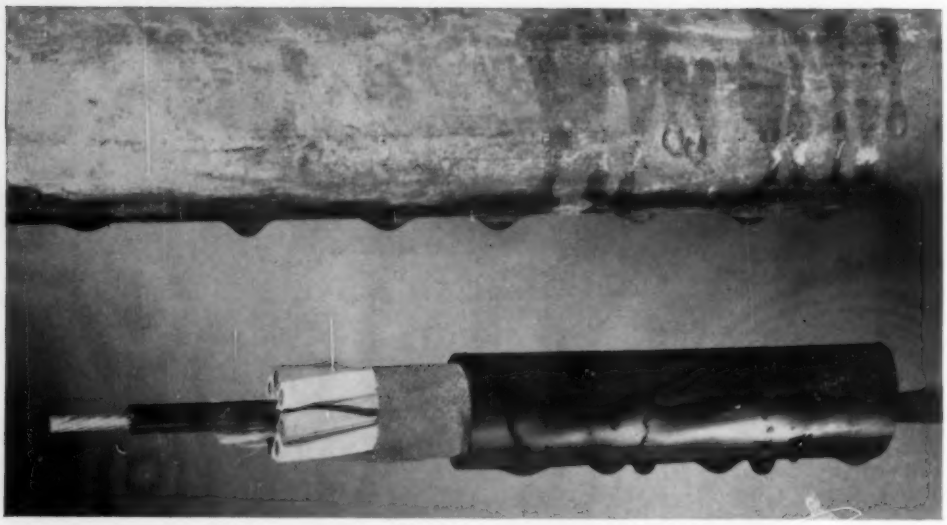

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Equipment

Screw Conveyor and Apparatus for Melting Synthetic Polymer Particles. No. 2,978,238. E. Crull, Obernburg (Main), Germany (to Vereinigte Glanzstoff-Fabriken AG., Wuppertal-Elberfeld, Germany).

Process and a Machine for the Production of Hollow Bodies. No. 2,978,745. E. Langecker, Meinerzhagen, Germany (to Gebr. Battenfeld, Minerzhagen, Germany).

Method of and Apparatus for Melting Organic Thermoplastic Plastics. No. 2,978,746. W. Rodenacker, Dormagan, Germany (to Farbenfabriken Bayer AG., Leverkusen, Germany).

Die for Extruding Tubular Plastic Film. No. 2,978,748. T. M. McCauley, La Grange, and G. Svoboda, Western Springs, Ill. (to Koppers Co., Inc., Pittsburgh, Pa.).

Rotary Oven. No. 2,979,765. F. N. Stephens, Prairie Village, C. C. Perkins, Jr., Mission, and T. J. Love, Jr., Shawnee, Kans. (to Gustin-Bacon Mfg. Co., Kansas City, Mo.).

Melt-Spinning Apparatus. No. 2,979,766. J. A. Briggs, Jr., and R. L. Gardner, Pensacola, Fla. (to Chemstrand Corp., Decatur, Ala.).

Apparatus for Extrusion of Plastics. No. 2,979,768. G. B. Nichols, 159 Homewood, Barberton, O. (one-half to R. F. Schnee. Barberton, O.).

Hydraulic Press Apparatus. No. 2,980,013. J. S. Swick and S. Rosen, New York, N. Y. (to Tronomatic Machine Mfg. Corp., New York, N. Y.).

Curling Fibers. No. 2,980,959. A. L. Genovese, Odenton, Md. (to National Plastic Products Co., Odenton, Md.).

Plastic Draw Press. No. 2,979,771. R. F. Taber, 111 Goundry St., N. Tonawanda, N. Y.

Molding Apparatus. No. 2,979,773. L. L. Bolstad, St. Louis Park, Minn. (to Minneapolis-Honeywell Regulator Co., Minneapolis, Minn.).

Plasticizing Head. No. 2,979,772. E. P. Moslo, 11720 Edgewater Dr., Lakewood, O.

Molding Press and Method of Molding. No. 2,979,770. K. F. Greene, Somerville, and W. L. Stafford, Martinsville, N. J. (to Johns-Manville Corp., New York, N. Y.).

Apparatus for Forming Hollow Articles from Thermoplastic Material. No. 2,980,955. D. C. Sanko, 215 A St., Boston 10, Mass. (One-half to L. J. Kovach, Brookline, Mass.).

Rotary Hydraulic Press. No. 2,980,960. D. Cropp, Warren, Pa. (to Warren Components Division, El-Tronics, Inc., Philadelphia, Pa.).

Rotary Press for Fabrication of Buttons and Plastic Articles. No. 2,976,555. F. Schwepke, Hamburg, Germany (to A. Mesa, Bogota, Colombia).

Method and Machine for Forming Articles from Plastic Sheet Material. No. 2,974,366. D. B. Bauman, New Haven, Conn. (to Applied Plastics, Inc., New Haven, Conn.).

Epoxy-Glass Fiber Systems and Method for Improving the Bonding Relation Therebetween. No. 2,974,062. T. J. Collier, Newark, O. (to Owens-Corning Fiberglas Corp.).

Control Mechanism for Servo Control of Hydraulic Press. No. 2,984,217. C. D. Cline, Mt. Gilead, O. (to Koehring Co., Milwaukee Wis.).

Method and Apparatus for Trimming Plastic Articles. No. 2,984,865. G. V. Mumford, Toledo, O. (to Owens-Illinois Glass Co.).

Apparatus for Forming and Heat Sealing Tubular Edgings to Thermoplastic Sheet Material. No. 2,985,221. Sidney H. Magid, Morrisville, Pa.

Method and Apparatus for Stretching Thermoplastic Sheet Material. Reissue no. 24,978. P. H. Bottoms, Hollywood, R. J. Clap and R. H. Loggins, Downey, and J. G. Stansbury, La Canada, Calif. (to Swedlow Inc.).

Molding Machine Die Locating Means and Method. No. 2,983, 957. C. S. Tudela, Richmond, Ind. (to National Automatic Tool Co., Inc., Richmond, Ind.).

Apparatus for Dispersing Pigments in Plastic Material. No. 2,982,990. J. Zomlefer, Leominster, Mass. (to Solar Chemical Corp., Leominster, Mass.).

Vacuumizing and Sealing Machine for Plastic Bags. No. 2,984,055. T. E. Piazze, Mt. Vernon, and R. B. Cook, Fredericktown, O. (to Continental Can Co., Inc., New York, N. Y.).

Control of the Edge Formation of Extruded Plastic Film. No. 2,982,995. J. E. H. L. Groleau, Cap de la Madeleine, Quebec, Canada (to St Regis Paper Co., New York, N. Y.).

Mandrel for Holding Insert During Injection Molding. No. 2,983,958. H. G. Fay, Rochester, N. Y. (to U. S A., Secretary of the Navy).

Apparatus for Metal Spray Molds. No. 2,982,996. M. Brucker, Los Angeles, Calif. (to Zenith Plastics Co., Gardena Calif.).

Apparatus for Fabricating Reinforced Plastic Tubing. No. 2,983,182. S. M. Shobert, Mashawaka, Ind.

Apparatus for Continuously Sealing Thermoplastic Materials. No. 2,983,306. J. Y. Resnick, 32 Elm St., Ellenville, N. Y.

Method and Apparatus for Forming Thermoplastic Plastic. No. 2,983,955. W. S. Gajdosik, 1848 W. 47th St., Chicago, Ill.

Injection Molding Machine. No. 2,983,056. R. A. Vogel, Jr., Lancaster, O., and G. C. Pulling, Birmingham, Mich. (to Essex Wire Corp).

Mixing Apparatus and Method, No. 2,976,565. E. E. Gyana, Flower Hill, N. Y. (to U. S. Rubber Co., New York, N. Y.).

Molding Apparatus for a Method of Forming a Prosthesis and the Like. No. 2,976,570. M. Ettenberg, 17 Shepherd Park, Waban 68, Mass.

Mold Venting Structure. No. 2,976,571. Ernest P. Moslo, Lakewood, O. (Moslo Machinery Co., 2443 Prospect Ave., Cleveland 15, O.).

Mixing Machines for Rubbers and Plastic Substances. No. 2,977,098. W. F. Watson and D. Wilson, Welwyn Garden City, England (to Baker Perkins, Ltd., Peterborough, England.).

Apparatus for Severing Plastic Material. No. 2,975,471. O. B. Sherman, Toledo, O. (to Owens-Illinois Glass Co.).

Method and Apparatus for Blowing Hollow Plastic Articles. No. 2,975,472. R. Colombo, Turin, Italy (to S.A.S. Lavorazione Materie Plastiche (L.M.P. di M. I. Colombo & C., Turin, Italy.).

Sheeting Die. No. 2,975,475. E. E. Heston, Akron, O. (to National Rubber Machinery Co., Akron, O.).

Mixing Nozzle. No. 2,975,478. K. C. Finster, Lake Jackson, Tex. (to Dow Chemical Co., Midland, Mich.).

Device for Seam Welding Thermoplastic Synthetic Materials. No. 2,975,824. E. Schenkengel, Kaiserslautern, Germany (to G. M. Pfaff AG., Kaiserslautern-Pfalz, Germany.).

Article Abstracts

Materials

"Adhesive Bonding of Reinforced Polyester," J. Leeuwerik, G. J. Spies and H. A. Bok, PLASTICA, 13, 12, 1208 (Dec. 1960).

Tensile strength at break was tested of glued assemblies of reinforced polyester/-reinforced polyester, and of reinforced polyester/duraluminum, with duraluminum/duraluminum as control. The control proved to be considerably stronger. With the right glue, lap joints gave breaks outside the glue line; with scarf joints, rupture always occurred at the glue line. However, scarf joints are generally stronger; apparently, the strength of the polyester and not of the glue is the deciding factor in lap joints. (In Dutch.)

"Kinetics of the Condensation of Polyols and Diisocyanates," S. Ronssin, IND. PLASTIQUES MOD., 13, 1, 13 (Jan.-Feb. 1961).

In this study, a polypropylene glycol of average molecular weight 2,000 was reacted with tolulene diisocyanates at different concentrations, with or without solvents. The course of the reaction can be followed by determining the unconsumed isocyanates in dilute medium, and by continuous measurement of viscosity in concentrated medium. (In French.)

"Effect of Aging on the Mechanical Properties of Glass/Polyester Resin Laminates," A. Kh. Iablokoff, IND. PLASTIQUES MOD., 13, 2, 25 (March 1961).

Aging experiments included were both natural and accelerated. Findings suggest that heat and humidity act only at the level of the glass/resin interface and of the glass fibers, while the other climatic factors (U-V rays, wind, ozone, electrical charge, etc.) act on the resin itself. (In French.)

"Contributions to the Analytical Chemistry of Plastics. XII. Investigations on the Saponification Products of Cellulose Triesters of Fatty Acids," K. Thinius and W. Munch, PLASTE U. KAUTSCHUK, 7, 12, 579 (Dec. 1960).

Various methods of saponifying cellulose fatty acid esters were studied and directions given for determining regenerated cellulose. (In German.)

"Study of the Destruction of Heat Stabilizers during Irradiation of P.V.C.," R. Gautron and C. Wippler, IND. PLASTIQUES MOD. 12, 8, 37 (Oct. 1960).

The incorporation of additives, as heat stabilizers, in PVC alters the effects of gamma radiation. Under irradiation, PVC stabilized with lead stearate becomes insoluble, whereas a sample stabilized with an organo tin derivative remains soluble even with a radiation dose in excess of 50 Mrad. With such doses, it seems clear that the stabilizer no longer retains its original properties. The authors describe two simple methods by which they are able to show that at the usual concentrations, a stabilizer is destroyed by a dose of only a few Mrad and there is a sudden change in physical properties of the PVC, especially in optical density and difference in potential. They determine the dose at which the stabilizer reacts completely to radiation and, by means of this value and certain hypotheses, calculate the radio-chemical energy of the attack on the polymer chains. Finally, they offer an explanation of the reaction. (In French.)

"The Organosols," C. Corso, MATERIE PLASTICHE, 26, 8, 731 (Aug. 1960).

Organosols are reviewed under three heads: preparation; rheological properties in relation to type of resin, amount and types of plasticizers, solvents and volatile diluents; time and temperature of fusion. (In Italian.)

"Thermal Stress in Polyethylene during Injection Molding," A. Stassen, PLAST-VERARBEITER, 11, 10, 450 (Oct. 1960).

Results are described of tests on the influence not only of processing and mold temperatures, but also of design of gating, length of flow path, stabilizers, on the quality of these moldings. (In German.)

"Materials for Casting Resin/Mineral Fiber. VI. Surface Treatment of Fiberglass for Reinforcing Plastics," A. Wende and M. Moebes, PLASTE U. KAUTSCHUK, 7, 7, 338 (July 1960).

The sizings and adhesives used for treating fiberglass for plastics reinforcement and how they are employed, are reviewed. The reaction mechanism of the adhesives is discussed and methods for testing the quality of impregnations with adhesives are described. (In German.)

In the reference system used, the first number following the magazine name is the volume number, the second is the issue number (if any), and the third is the first page on which the abstracted article appears in that magazine.

Requests for copies, reprints, or further information on any article abstracted in this department should be addressed to the publisher of the magazine where the article appeared. A complete listing of the publishers and addresses of these magazines is printed here quarterly.

The next complete listing will appear in January. The last listing appeared in the September issue.

"Dynamic and Static Rupture of Plastics," B. Bossu and P. Dubois, IND. PLASTIQUES MOD., 12, 8, 25 (Oct. 1960).

Thermoset or rigid thermoplastics based on polymers irregular at room temperature, polystyrene for instance, are those chiefly subject to sudden rupture under impact or the gradual effect of flexing. The authors attempt to explain the mechanism of this rupture which is clearly produced by pure flexing or flex-shear. Since samples are flex-tested either clamped or lying between supports, two types of rupture under impact tests are examined: pure flexing (Charpy) and flex-shear (Izod and Bynstai). (In French.)

"Black Polyethylene," F. Nano, MATERIE PLASTICHE, 26, 12, 1140 (Dec. 1960).

The method and equipment used in preparing black polyethylene are described, as well as tests to determine carbon black content; to evaluate dispersion; and to show the relation of absorption rate and aging. (In Italian.)

"Environmental Stress Rupture of Polyethylene," L. L. Lander, SPE J., 16, 12, 1329 (Dec. 1960).

A simpler test method than the Bent Strip Test is presented to provide more reproducible results on stress failure in solvent environments.

"Effects of Temperature on Filled Epoxy Encapsulation Materials," B. A. Davis, SPE J., 16, 12, 1333 (Dec. 1960).

Shielding a mold reduces heat losses, prevents voids, and improves surface finishes in filled epoxy castings.

"Melt Index Equivalent—A New Flow Parameter," R. J. Martinovich, P. J. Boeke, and R. A. McCord, SPE J., 16, 12, 1335 (Dec. 1960).

A method is given for predicting the effect of differing molecular weight distributions on polymer properties.

"Naphthalene Polymers." S. A. Bafna, INDIAN PLASTICS REVIEW, No. 8, 12 (Aug. 1960).

A brief review of these polymers and their uses.

"Silane Coupling Agents in Glass-Reinforced Plastics," B. M. Vanderbilt and J. P. Simko, Jr., MODERN PLASTICS, 38, 4, 135 (Dec. 1960).

A revised version of a paper presented originally at the SPI Reinforced Plastics Division conference in February, 1960.

"Predicting Mold Flow by Electronic Computer," H. L. Toor, R. L. Ballman, and Leon Cooper, MODERN PLASTICS, 38, 4, 117 (Dec. 1960).

It is shown that the gross flow process may be predicted from the rheological and thermal properties of the polymer by simultaneously solving approximate forms of the energy equation and the equation of motion on a digital computer.

"What Users Think of Polypropylene," M. W. Riley, MATERIALS DESIGN ENG., 52, 7, 117 (Dec. 1960).

An appraisal based on interviews with engineers.

"Fluidized-Bed Coating — A Growing outlet for Plastics," P. W. Sherwood, PLASTICS (LONDON), 25, 278, 495 (Dec. 1960).

A brief review of the method for preparing certain plastics resins.

"Determination of the Structure of Copolymers by Light Scattering. Characterization of their Heterogeneity," H. Benoit and M. Long, IND. PLASTIQUES MOD., 12, 9, 25 (Nov. 1960).

If the molecular weight of a copolymer in different solvents is measured by light scattering, it is possible to determine the molecular weights of the different monomers, as well as a parameter characterizing heterogeneity. A parallel study of radius of gyration gives information on the structure of the polymers. Values for gyration radius are obtainable for different parts of the copolymer. Then by comparing the experimental data with calculated data, the structure model deduced from the kinetics of polymerization can be verified. (In French.)

"Deshrinking Thermoplastic Sheet," H. Haldenwanger, KUNSTSTOFF-RUNDSCHAU, 7, 10, 469 (Oct. 1960).

Shrinkage of thermoplastic sheet is caused by internal opposing stresses and is reduced by heat treatment, the conditions for which largely depend on the temperature of the so-called "apparent deformation" above which shrinkage occurs. A test to determine apparent deformation temperature is indicated, and methods of avoiding internal stresses during manufacture are mentioned. (In German.)

"Polymerization of Caprolactam," O. Wichterle, PLASTIQUES INFORMATIONS, 11, 232, 2 (Aug. 1, 1960).

This is a reproduction of an article originally appearing in Die Makromolekulare Chemie, Jan. 1960, reporting Czechoslovakian research on alkaline polymerization of caprolactam. A probable mechanism of alkaline polymerization is discussed, as well as the accompanying secondary reactions. Also examined is the unusually rapid alkaline polymerization occurring in presence of certain imides used as co-catalysts, which was discovered by Sebenda and Kralicek in connection with these investigations. (In French.)

"On the Hydrolysis of Polyesters," P. Fijolka and I. Lenz, PLASTE U. KAUTSCHUK, 7, 7, 336 (July 1960).

The hydrolysis was studied of linear polyesters from various acids and diols, dissolved in acetone and then saponified with potash lye at 20° C. The rate of hydrolysis was found to depend on the acid and alcohol components of the polyester, and hydrolysis rate constants were determined for the most commonly used saturated acids and diols. (In German.)

"Relation of Temperature to Crystallization Rate of Low Pressure Polyethylene," J. Majer, KUNSTSTOFF RUNDSCHAU, 7, 8, 373 (Aug. 1960).

Data obtained in studies on the kinetics of crystallization of Ziegler low-pressure polyethylene were utilized to test the theories proposed by Mandelkern and Kahle/Stuart, respectively, for the relation of total crystallization rate to temperature. Assuming that melting point is correctly determined, the results cited tend to support the Kahle/Stuart theory, rather than that of Mandelkern. (In German.)

Equipment

"Determining the Output from Single-Screw Extruders, Taking Frictional Forces into Account but Ignoring Back Pressure," R. M. Kruglikov and S. M. Rips, SOVIET PLASTICS, No. 7, pg. 54 (July 1961).

A nomograph is given on calculated output.

"Self-Recording Instrument for Studying Heat Softening of Films," P. van der Steen, PLASTICA, 14, 1, 32; 14, 2, 130 (Jan. & Feb., 1961).

Designed to test four samples at a time, the device is used for determining the heat-softening curves of new synthetics, and the effect on softening of the various processes and changes a polymer undergoes. (In Dutch.)

"Design of Extruder Dies," R. Anguita, REV. PLASTICOS, 12, 67, 23 (Jan.-Feb., 1961).

Discussion of the design of extruder dies and heads for covering wire, producing tubular film, blown film and sheet. (In Spanish.)

"Effects of Recent Fundamental Investigation on Extruder Design. Part 1," G. P. M. Schenkel, INTL. PLASTICS ENG., 1, 6, 315 (July 1961).

This beginning of a four-part study covers energy balances in an extruder during operation.

"Plastifying Extrusion," L. F. Street, INTL. PLASTICS ENG., 1, 6, 289 (July 1961).

An enlarged version of a 1961 SPE Antec paper on plastifying processes in an extruder.

"How to Hot Hob Beryllium Copper," Islyn Thomas, MODERN PLASTICS, 38, 11, 101 (July 1961).

Discussion of pressure casting and its advantages in mold making.

"The Heating of Injection Cylinders," W. R. Groves, INTL. PLASTICS ENG., 1, 6, 283 (July 1961).

Description and discussion of work carried out on spreader heating temperatures.

"Undercuts on Injection Moldings," G. Ward, INTL. PLASTICS ENG., 1, 6, 274 (July 1961).

The methods in mold making for handling tool problems caused by undercuts.

"Selecting Equipment for Automatic Injection Molding Operations," W. G. Kriner, PLASTICS AUSTRALIA, 12, 7, 25 (July 1961).

A reprint of a 1961 SPE Antec paper dealing with molds and machinery.

"Injection Molding Tool for Electric Plug with Mains Lead," H. Gastrow, KUNSTSTOFFE 51, 8, 455 (Aug. 1961).

A tool and its application in injection molding are described.

Applications

"'Prepregging' the Hustler," R. Thompson, PLASTICS WORLD, 19, 6, 58 (June 1961).

How laminates are used in the skins for the supersonic airplane.

"Minimizing the Dimensional Instability of Thermoformed Articles," R. H. Bretton & F. A. Welham, BRIT. PLASTICS, 34, 5, 244 (May 1961).

Careful selection of materials is necessary for dimensional stability.

"Heat Stabilized Flame Retarded Polyethylenes for Wires and Cables," P. M. Cook, R. W. Muchmore, & H. Rapp, RUBBER & PLASTICS AGE, 42, 5, 522 (May 1961).

The material and its properties in these applications.

"Plastics for Solid Propellents," A. J. Zaehringer, MODERN PLASTICS, 38, 9, 225 (May 1961).

Some of the basic problems of rocket fuels have been solved by plastics as fuel binders.

"Swedish Packaging," N. Galletti, MAT. PLASTICHE, 27, 2, 152 (Feb. 1961).

A review of small containers and bags made of plastics in Sweden. (In Italian.)

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"Quality Insurance of Thermosetting Moldings," E. Motzkus & H. Wallhaufer, KUNSTSTOFFE, 51, 5, 264 (May 1961).

A way to insure that moldings meet the required quality is described.

"Polyethylene for Milk Transportation in Scandinavia," F. A. Abadie, IND. PLASTIQUES MOD., 13, 1, 2 (Jan.-Feb. 1961).

Scandinavian manufacturers are now making high-pressure polyethylene milk cans (31-52 quarts), which have withstood severe tests as to mechanical strength, chemical resistance, facility of cleaning; resistance to temperature variations; and effect on taste, odor and bacterial development of milk when stored. (In French.)

"Reinforced Plastics During the Past Three Years," J. O. W. van Dugteren, PLASTICA, 13, 10, 938 (Oct. 1960).

The author reviews the progress in the use of glass-reinforced plastics in the Netherlands in the last three years, especially in ship-building, chemical apparatus, railway coaches, and the building and electrical industries. (In Dutch.)

"Plastics in the Electronics Industry,' H. A. K. Eden, PLASTICA, 13, 11, 1108 (Nov. 1960).

After explaining the general principles of selecting a plastics material and judging its usefulness, the author deals in particular with applications of thermosets and thermoplastics as structural elements and as dielectrics for the electronics industry. He considers dimensional stability and the factors involved in considerable detail, and calls special attention to the importance of dynamic-mechanical investigations. (In Dutch.)

"New Type of Airex Sandwich Doors for Ships' Refrigeration Compartments," G. Descamps and L. Taal, IND. PLASTIQUES MOD., 13, 1, 6 (Jan.-Feb. 1961).

With Dutch, Belgian and Swiss collaboration, Aire-Sandwich material (cellular PVC combined with polyester laminate) has been successfully used in the construction of very large, tight, sliding doors for ships' refrigeration compartments. (In French.)

"Applications of Silicones Combined with Glass Fabric," P. H. Morel, OFF. MAT. PLASTIQUES, 8, 79, 239 (March 1961.)

The author discusses the industrial uses of combinations of glass fabrics and silicones in sizing, electrical insulations, laminates, conveyor belts, heating mats and panels, protective garments and protective metallized bands. He deals chiefly with developments in America and France, which he compares, and gives economic and other reasons for the French lag in certain fields. (In French.)

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CALENDAR of COMING EVENTS

October 16-19
TAPPI Engineering Conference. Economic Solutions through Engineering. Shoreham Hotel, Washington, D. C.

October 17
Building Research Institute. Planning Committee on Plastics in Building. Princeton, N. J.

October 25
SPE Kentuckiana Section RETEC. Plastics in Major Household Appliances. Monogram Hall, General Electric Co., Appliance Park, Louisville, Ky.

October 26-27
Plas-Tech Equipment Corp. Third Annual Symposium on High-Speed Testing. Hotel Somerset, Boston, Mass.

November 2-3
SPE North Texas Section RETEC. Plastics in Packaging and Engineering Exhibition. Sheraton-Dallas Hotel, Dallas, Tex.

November 7-10
Packaging Machinery Manufacturers' Institute Show of 1961. Cobo Hall, Detroit, Mich.

November 15
SPE New York Section RETEC. Vinyl Plastics in the Household. Statler-Hilton Hotel, New York, N. Y.

November 26-December 1
ASME Winter Annual Meeting. Statler-Hilton Hotel, New York, N. Y.

November 28-30
Building Research Institute. 1961 Fall Conferences. Mayflower Hotel, Washington, D. C.

November 29-December 1
U. S. Army Signal Research and Development Laboratory. Wire and Cable Symposium. Berkeley-Carteret Hotel, Asbury Park, N. J.

December 1
SPE Cleveland Section RETEC. Plastics Screw Injection Molding. Sheraton-Cleveland Hotel, Cleveland, O.

January 30-February 2
SPE 18th ANTEC. Penn-Sheraton Hotel, Pittsburgh, Pa.

February 6-8
SPI 17th Reinforced Plastics Division Conference. Edgewater Beach Hotel, Chicago, Ill.

March 6-7
Society of Vacuum Coaters. 5th Annual Technical Conference. Sheraton-Cleveland Hotel, Cleveland, O.

March 20-29
American Chemical Society. 141st National Meeting. Washington, D. C.

April 4-6
SPI 19th Western Section Conference. Hotel del Coronado, Coronado, Calif.

April 17
SPE Philadelphia Section RETEC. Polypropylene's Expanding Position in Plastics. Sheraton Hotel, Philadelphia, Pa.

May 10-11
SPE Newark Section Workshop. Encapsulation: Materials and Techniques. Military Park Hotel, Newark, N. J.

May 28-29
SPI 20th Canadian Section Conference. Chateau Frontenac, Quebec City, Que., Can.

May 19-29
Europlastique 62. Terrace R, Exhibition Park, Paris, France.

Abstracts of Important Articles (Cont'd.)

General

"Twelfth International Congress at Turin," G. Longoni, POLIPLASTI, 8, 43, 51 (Nov.-Dec. 1960).

Out of 47 papers presented at this Congress, 15 dealt with reinforced plastics. Abstracts are presented of most of the papers; one, proposing Italian standards for corrugated roofing of glass-reinforced polyester resin, is reported in special detail. (In Italian.)

Long-Term Market Forecasting in the Plastics Industry," Heather Campbell, PLASTICS AUSTRALIA, 12, 4, 21 (April 1961).

Long-term market forecasting is shown to depend on the future trend of developments, rather than on actual sales for a particular year.

"10th Meeting of ISO/TC 61; Plastics, Praha, October 17-22, 1960," A. Melichia, MAT. PLASTICHE, 27, 2, 109 (Feb. 1961).

After briefly mentioning progress made on the subjects proposed for study during the past 10 years, the author reports on the proceedings and recommendations offered at the tenth meeting. (In Italian.)

"Principal World Markets for Plastics Materials in 1959," G. Moretti, MAT. PLASTICHE, 26, 12, 1107 (Dec. 1960).

General comparison of production and foreign trade of leading producers and of world consumption in 1959 and 1958, and separate discussions of the situation in the United States, West Germany, United Kingdom, France, and Japan. (In Italian.)

Domestic Production and Sales of Plastics and Resin Material, May and June, 1961

Following are the partly estimated and revised statistics for the domestic production and sale of plastics and resinous material during the months of May, and June, 1961. Units listed are in pounds, dry basis unless otherwise specified. Data on alkyds and rosin modifications have not been included since their use is primarily limited to the protective coating industry.

	May, 1961		June, 1961	
	Production	Sales	Production	Sales
Cellulose Plastics:				
Cellulose acetate and mixed ester:				
Sheets, under 0.003 gage	1,590,187	1,565,902	1,762,458	1,695,225
Sheets, 0.003 gage and over	1,965,127	1,935,838	2,687,071	2,681,966
All other sheets, rods, and tubes (including other cellulose plastics)	840,285	943,609	566,675	600,856
Molding and estrusion materials (including cellulose plastics)	7,474,753	7,303,810	7,924,380	7,160,927
Nitrocellulose sheets, rods, and tubes	103,246	73,077	105,642	92,735
TOTAL	11,973,598	11,912,236	13,046,226	12,231,709
Phenolic and Other Tar-Acid Resins:				
Molding materials	17,382,592	16,475,486	19,072,158	17,543,153
Bonding and adhesive resins for—				
Laminating (except plywood)	5,703,974	3,639,029	5,915,952	3,837,384
Coated and bonded abrasives	1,108,485	1,108,639	1,166,932	1,035,872
Friction materials (brake linings, clutch facings, and similar materials)	1,411,993	1,103,124	1,545,555	1,356,749
Thermal insulation (fiber glass, rock wool)	7,494,495	4,144,927	7,362,459	3,954,554
Plywood	6,126,809	5,493,538	5,403,241	5,026,750
All other bonding and adhesives uses	6,286,176	5,656,549	6,451,788	5,275,904
Protective-coating resins unmodified and modified except by rosin	1,812,564	1,664,635	1,819,125	1,672,066
Rosins for all other uses	4,146,254	3,792,575	3,824,052	3,714,555
TOTAL	51,482,292	43,078,502	52,565,262	43,416,987
Urea and Melamine Resins:				
Textile-treating and textile-coating resins	2,388,148	2,168,875	2,296,410	2,187,750
Paper-treating and paper-coating resins	2,130,601	2,023,524	2,542,097	2,398,111
Bonding and adhesive resins for—				
Laminating	3,078,680	2,332,880	2,803,267	2,227,918
Plywood	8,658,861	7,893,326	8,185,100	7,494,305
All other bonding and adhesive uses	4,018,507	3,732,608	3,587,845	3,858,255
Protective-coating resins, straight and modified	3,255,436	2,397,063	3,333,900	2,232,606
Resins for all other uses, including molding	8,548,282	9,332,907	9,269,991	9,890,024
TOTAL	37,078,515	29,881,183	31,918,610	30,289,069
Styrene Resins:				
Molding and extrusion materials:				
Straight polystyrene	26,095,722	21,713,859	25,480,013	21,356,875
All other	38,710,754	33,637,868	40,043,487	33,502,772
Protective-coatings	6,809,293	5,637,460	6,295,689	5,133,946
Textile and paper treating and coating resins	6,448,041	5,175,547	6,152,936	5,228,174
All other uses	14,642,778	19,696,591	14,887,159	21,842,933
TOTAL	92,706,588	85,861,325	92,859,284	87,064,700
Vinyl and Vinyl Chloride Resins:				
Polyvinyl chloride and copolymer resins (50% or more PVC) for—				
Film (resin content)		8,833,009		8,500,151
Sheeting (resin content)		11,396,552		10,911,244
Molding and extrusion (resin content)		26,030,303		27,605,651
Textile and paper treating and coating (resin content)		5,936,419		6,100,393
Flooring (resin content)		15,346,104		15,258,068
Protective coating (resin content)		3,437,067		3,561,522
All other uses (resin content)		10,442,340		9,940,404
All other vinyl resins for—				
Adhesives (resin content)		5,817,684		5,632,701
Protective coatings (resin content)		3,016,948		2,658,961
All other uses (resin content)		10,580,104		11,050,911
TOTAL	104,463,724	100,836,530	104,413,789	101,220,006
Coumarone-Indene and Petroleum Polymer Resins	18,174,491	18,976,108	18,645,375	18,738,677
Polyester Resins:				
For reinforced plastics	12,408,473	12,236,332	11,157,176	10,748,600
For all other uses	2,750,012	1,993,730	1,802,224	2,040,849
TOTAL	15,158,485	14,230,062	12,959,390	12,789,449
Polyethylene Resins:				
For film and sheeting		46,229,489		48,240,366
Molding materials		19,200,771		19,903,930
Extrusion materials		17,901,363		15,368,059
For all other uses		51,337,251		43,790,391
TOTAL	128,955,002	135,668,874	132,789,092[1]	127,302,746[2]
Polypropylene Resins:				
Epoxy Resins:	7,642,693	4,797,158	7,502,765	5,808,340
For protective coatings		2,184,673		2,600,073
For all other uses		2,821,729		3,056,016
TOTAL	5,059,458	5,006,402	5,494,935	5,656,089
Silicone Resins		624,047	567,774	570,059
Miscellaneous Synthetic Plastics and Resin Materials	24,877,238	21,767,405	25,350,341	22,774,461
GRAND TOTALS	498,572,084	472,639,832	498,112,843	467,862,292

[1] 18.3% produced by the low-pressure process.
[2] 15.0% produced by the low-pressure process.
SOURCE: United States Tariff Commission Chemical Division.

Current Market Prices

Prices in general are f.o.b. works. Ranges indicates variations in grade, quality, quantities, and geographical locations of customers. No guarantee of these prices is made, and spot prices should be obtained by contacting this publication.

Catalysts

Ammonium thiocyanate	lb.	$0.1725	$0.26
Peroxide, acetyl, 25% in DMP	lb.	1.75	4.00
Benzoyl, dry, 96%	lb.	.88	2.00
Wet, 50% paste in TCP	lb.	.89	2.25
in silicone fluid	lb.	2.75	5.00
55% in BBP	lb.	.89	2.25
Caprylyl, liquid, 50% in mineral oil	lb.	4.45	5.50
In DOP	lb.	5.00	
Cyclohexanone, 45% paste in DBP	lb.	2.00	3.00
Powder, 85%, in DBP	lb.	3.00	4.00
p-Chlorobenzoyl, paste, 50%			
In mineral oil	lb.	4.25	5.00
In TCP	lb.	5.00	
2,4-Dichlorobenzoyl, 50% in silicone oil	lb.	2.00	4.25
40% in silicone oil	lb.	4.25	6.00
Di-t-butyl	lb.	1.75	4.00
Lauroyl	lb.	1.55	3.50
Other peroxides	lb.	1.55	5.00

Colorants

Black, std.	lb.	.90	4.10
Carbon black	lb.	.0575	.87
Paste	lb.	.65	.74
Bone blacks	lb.	.155	.2775
Colloidal dispersions	lb.	.66	1.45
Aqueous	lb.	.115	.395
Gel coats	lb.	.61	.86
Iron oxide	lb.	.1275	.23
Lampblack	lb.	.1225	.175
Masterbatch	lb.	.60	.63
Paste (for epoxies)	lb.	1.58	2.15
(for vinyls)	lb.	.50	.66
Paste dispersion	lb.	.85	1.90
Paste concentrate	lb.	.82	1.20
Pigment dispersion	lb.	.83	1.15
Blue, std.	lb.	.90	2.75
Concentrate	lb.	.95	3.00
Masterbatch	lb.	.85	1.13
Pearl	lb.	1.38	
Metallic	lb.	.02	
Paste (for epoxies)	lb.	1.25	2.60
(for vinyls)	lb.	.62	1.84
Paste dispersion	lb.	.85	2.40
Paste concentrate	lb.	.78	.80
Phosphorescent	lb.	.24	
Brown, std.	lb.	.87	4.00
Copper tinsel	lb.	.10	
Gel coats	lb.	.59	1.04
Iron oxide	lb.	.15	.24
Metallic bronze	lb.	.02	
Paste (for epoxies)	lb.	1.18	1.47
(for vinyls)	lb.	.48	1.67
Paste dispersions	lb.	.75	1.70
Paste concentrate	lb.	.65	2.30
Gold, metallic	lb.	.21	
Paste dispersions	lb.	1.40	1.60
Tinsels	lb.	.10	
Gray, gel coat	lb.	.59	.84
Paste (for epoxies)	lb.	1.40	
Paste dispersion	lb.	1.45	2.20
Green, std.	lb.	.90	3.25
Chromic oxide	lb.	.45	1.40
Concentrate	lb.	.95	3.00
Masterbatch	lb.	1.20	1.23
Metallic	lb.	.21	
Paste (for epoxies)	lb.	2.86	
(for vinyls)	lb.	.80	1.83
Paste dispersions	lb.	.85	2.70
Paste concentrate	lb.	.80	2.15
Pearl	lb.	.10	
Phosphorescent	lb.	.24	
Orange, dry	lb.	.49	3.50
Gel coat	lb.	.75	1.05
Lithopone	lb.	1.63	1.86
Paste (for epoxies)	lb.	1.58	
(for vinyls)	lb.	.74	4.27
Concentrate	lb.	1.58	
Dispersion	lb.	.55	2.80
Purple, pearl	lb.	.10	
Red, std.	lb.	.1425	5.00
Cadium lithopone	lb.	1.90	2.86
Selenide	lb.	4.60	7.15
Concentrate	lb.	2.25	2.50
Iron oxide	lb.	.0475	.205
Metallic	lb.	.021	
Masterbatch	lb.	.75	.88
Paste (for epoxies)	lb.	2.35	3.77
(for vinyls)	lb.	1.20	3.82
Concentrate	lb.	5.42	6.49
Dispersions	lb.	.90	3.05
Venetian	lb.	.065	.1325
Silver, metallic	lb.	.0165	
Paste (for epoxies)	lb.	1.55	
(for vinyls)	lb.	.89	.91
Dispersion	lb.	$0.85	$1.45
Concentrate	lb.	1.02	
Tinsels	lb.	.10	
Yellow, std.	lb.	.12	3.50
Cadium lithopone	lb.	1.21	1.29
Concentrate	lb.	1.00	2.50
Gel coat	lb.	.61	1.03
Iron oxide	lb.	.1225	.1875
Masterbatch	lb.	.90	.93
Paste (for epoxies)	lb.	2.15	2.55
(for vinyls)	lb.	.58	3.70
Concentrate	lb.	.65	2.87
Dispersions	lb.	.90	2.20
White, std.	lb.	.44	4.00
Concentrate	lb.	.70	1.25
Gel coat	lb.	.59	.84
Masterbatch	lb.	.75	.80
Paste (for epoxies)	lb.	1.02	
(for vinyls)	lb.	.48	.60
Concentrate	lb.	.705	.725
Dispersion	lb.	.70	2.00
Pearl	lb.	.10	

Fillers

Aluminum silicate pigments	ton	21.50	65.00
Barytes	ton	60.00	123.00
Paste concentrate	lb.	.705	.725
Calcium carbonate, ppt	ton	30.00	187.00
Std.	ton	15.00	35.00
China clay	ton	40.00	
Flours	ton	50.00	106.00
Flocks, cotton	lb.	.12	.30
Rayon	lb.	.50	1.25
Nylon	lb.	.35	2.75
Mica	lb.	.075	4.44
Silica	ton	25.00	48.50
Whiting	ton	8.75	13.25
Oyster shell	lb.	30.00	
Wollastonite	ton	29.00	47.50

Miscellaneous

Anti-Fog	gal.	8.69	16.95
Anti-Static	gal.	3.57	8.50
(for films)	gal.	8.00	8.50
Odorants	lb.	1.25	10.00
Purging cmpd. (for injection)	lb.	.40	
Wetting agent (for dry coloring)	gal.	2.50	3.20
(for wet operations)	lb.	2.39	3.69

Mold Release Agents

Silicone type: Cmpds	lb.	4.70	5.20
Aerosols	20 oz. can	.80	1.00
Emulsions	lb.	1.09	1.65
Solvent type	lb.	.40	4.95
Fluids	lb.	2.74	6.00
Stearates: Barium	lb.	.41	.46
Calcium	lb.	.39	.44
Magnesium	lb.	.42	.47
Zinc	lb.	.41	.48

Plasticizers

Adipate, Butyl Cellosolve	lb.	.45	.47
Dibutoxyethyl	lb.	.425	.46
Didecyl	lb.	.265	.375
Diisodecyl	lb.	.35	.385
Diisobutyl	lb.	.41	.44
Diisooctyl	lb.	.36	.435
Dioctyl	lb.	.35	.385
2-Ethyl hexyl	lb.	.35	.435
Isooctylisodecyl	lb.	.40	.435
Isooctyl	lb.	.49	.535
n-Octyl decyl	lb.	.35	.44
Azelate, dioctyl	lb.	.41	.49
Di-2-ethyl hexyl	lb.	.40	.465
Dibenzoate, Diethylene glycol	lb.	.285	
Diethylene glycol	lb.	.45	.60
Triethylene glycol	lb.	.60	
Epoxy, polymeric	lb.	.3225	.3525
Monomeric	lb.	.3475	.3775
Ester, Fatty Acid	lb.	.3525	.3775
Monomeric	lb.	.35	.60
Laurate, Butoxyethyl	lb.	.39	.40
Oleate, Butyl	lb.	.24	.37
Butoxyethyl	lb.	.30	.33
Methoxyethyl	lb.	.31	.34
Phosphate, Tributyl	lb.	.50	.535
Tricresyl	lb.	.325	.36
Phthalate, Butyl Cellosolve	lb.	.35	.385
Butyl octyl	lb.	.255	.30
Cyclohexyl	lb.	.265	.305
Isodecyl	lb.	$0.24	$0.28
Butoxyethyl	lb.	.365	.37
Dibutyl	lb.	.28	.32
Dicaprvl	lb	265	44
Dicyclohexyl	lb.	.41	.59
Didecyl	lb.	27	
Diisodecyl	lb	.24	.45
Diisooctyl	lb.	.26	.445
Dioctyl	lb.	.235	.305
Isooctyldecyl	lb.	.24	.28
Methoxyethyl	lb.	.355	.405
Polyester type	lb.	.34	.7125
Polymeric type	lb.	.39	.93
High-solvating	lb.	.37	.425
Ricinoleate type	lb.	.32	.35
Sebacate, Dibenzyl	lb.	.91	1.04
Dibutyl	lb.	.655	.785
Dioctyl	lb.	.57	.6825
Soy Bean oil, epoxidized	lb.	.3235	.4775
Stearate, Butyl	lb.	.235	.395
Butoxyethyl	lb.	.31	.32
Epoxized octyl	lb.	.3475	.5325
Methoxyethyl	lb.	.32	.35
Octyl epoxy	lb.	.3925	.447
Tallate, Octyl epoxy	lb.	.3475	4.025

Resins, Molding, Casting & Coating

ABS type	lb.	.44	1.15
Acetal	lb.	.65	.93
Colors	lb.	.74	1.24
Acrylic	lb.	.46	1.08
Alkyd	lb.	.1325	1.20
Allyl (diallyl phthalate)	lb.	.95	2.50
Carbonate	lb.	1.30	2.25
Cellulosics:			
Cellulose acetate	lb.	.35	.68
Reprocessed	lb.	.25	.36
Cellulose acetate-butyrate	lb.	.40	.81
Reprocessed	lb.	.35	.45
Cellulose propionate	lb.	.40	.81
Ethyl cellulose	lb.	.67	
Reprocessed	lb.	.30	
Epoxy, liquid	lb.	.60	1.41
Solid	lb.	.51	1.31
Ethylene copolymers	lb.	.32	.95
Fluorocarbons	lb.	3.25	11.00
Furane	lb.	.75	1.00
Liquid	lb.	.32	.44
Melamine	lb.	.57	.70
Coating solns.	lb.	.3275	.4375
Phenolic	lb.	.207	1.12
Coating solns.	lb.	.305	.3525
Polyamide	lb.	.62	1.26
Coatings	lb.	.61	1.51
Graphite-filled	lb.	1.40	1.83
Heat-stabilized	lb.	1.09	1.55
Molybdenum sulfide-filled	lb.	1.19	2.07
Polycarbonate	lb.	1.30	2.29
Polyester, powder	lb.	.26	2.20
Coating	lb.	.0975	.1275
Glass-reinforced	lb.	.41	.80
Polyethylene, low-density	lb.	.2375	.615
Medium-density	lb.	.2375	.6425
High-density	lb.	.275	1.59
Polypropylene	lb.	.42	1.17
Reprocessed	lb.	.50	
Polystyrene	lb.	.18	1.34
Reprocessed	lb.	.15	.26
Rubber-modified	lb.	.20	.275
Polyurethane	lb.	1.30	7.50
Silicones, casting	lb.	7.50	11.40
Molding	lb.	2.40	3.55
Urea coating solns.	lb.	.205	.27
Vinyl, dispersion grade	lb.	.24	.325
Copolymers	lb.	.2025	.44
Molding	lb.	.185	.66
Nitrile rubber blend	lb.	.45	.53
Reprocessed	lb.	.19	.22
Vinyl-vinylidene copolymer	lb.	185	.32
Vinylidene	lb.	.205	6.00
Latex	lb.	.45	.52

Solvents

Ketones: Acetate	lb.	08	.22
Methyl isoamyl	lb.	.175	.315
Esters: Ethyl acetate	lb.	.125	.2675
Isopropyl acetate	lb.	.115	.255
n-Butyl acetate	lb.	.145	.285
Alcohols: Isobutyl	lb.	.13	.27
n-Butyl	lb.	.155	.295

Stabilizers

Alkyd tin mercaptide, liq.	lb.	2.50	3.15
Barium-cadmium complex:			
Liquid	lb.	.50	.58
Solid	lb.	.97	1.255
Barium-cadmium laurate	lb.	.87	.90
Myristate	lb.	.72	.75
Barium-cadmium-zinc complex	lb.	.54	.56
Barium-zinc, liquid	lb.	.58	.615
Powder	lb.	.375	.44
Complex	lb.	.47	.50
Cadmium-barium, powder	lb.	.68	.895
Chelating agent, liquid	lb.	.57	.84
Cadmium-containing	lb.	.84	.87
Zinc-containing	lb.	.62	.80
Organic complex, liquid	lb.	.57	.84
Strontium-zinc laurate	lb.	.72	.75
Zinc, liquid	lb.	.48	.52

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ADVANTAGES

- Contamination and cleanout reduced to a minimum.
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- Treatment of pellets always uniform.
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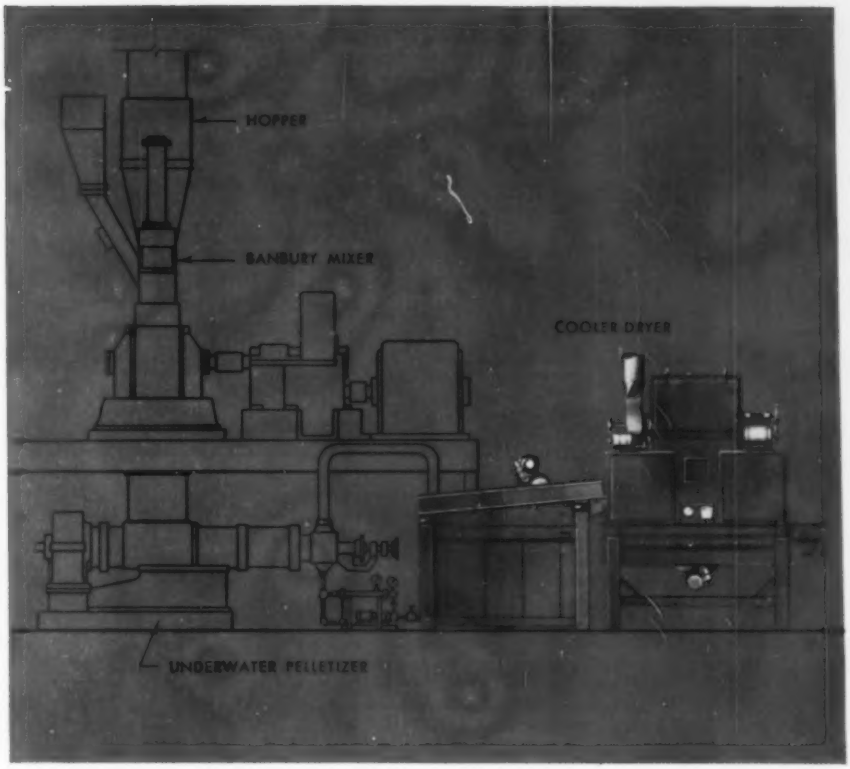

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IMPROVED COOLER-DRYER

for Polyolefin and PVC pellets

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Designed for greater processing efficiency, the unit handles the discharge of polyolefin pellets extruded through a Farrel underwater pelletizing head. The design is based on a new development in high-velocity jet drying; capacities range from 1,000 to 12,000 pounds per hour.

Called the "Jetzone"* principle, it eliminates the need for perforated decking in the drying zone . . . reducing contamination and cleanout to a minimum. With the high-velocity principle, heat transfer is five to ten times more efficient, making the unit smaller for a given production.

The operational sequence is as follows: Free water is drained away through an independently driven vibrating screen as the circulating water and product enter the inlet to the dewatering section. The action of the dewatering deck propels the pellets forward and up the inclined deck to the discharge spout. While travelling across the screen the pellets are separated from all free water and fines. The latter are washed down to a catch screen, and the water is returned to a reservoir.

At the end of the dewatering screen the pellets enter a discharge spout, attached to the drying section inlet by a flexible boot. A stainless-steel vibrating pan conveys the pellets along its length. Within this drying zone, air is heated and pressurized before being expelled upon the agitated pellets. Circulated air is blown through jets in a pattern above the product bed and impinges on the product at speeds of from 3500 to 10,000 feet per minute. This high velocity air causes the pellets to "boil," thus exposing the entire surface of each to the air. At the discharge end of the drying section, the pellets pass over a sizing screen which separates any "overs" from the product.

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FB-1222

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DELRIN has had an impact not only in the field of pumps—as indicated above—but also in such diverse areas as automotive components, plumbing and hardware fixtures, sporting goods, appliance parts, business machines and many others.

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